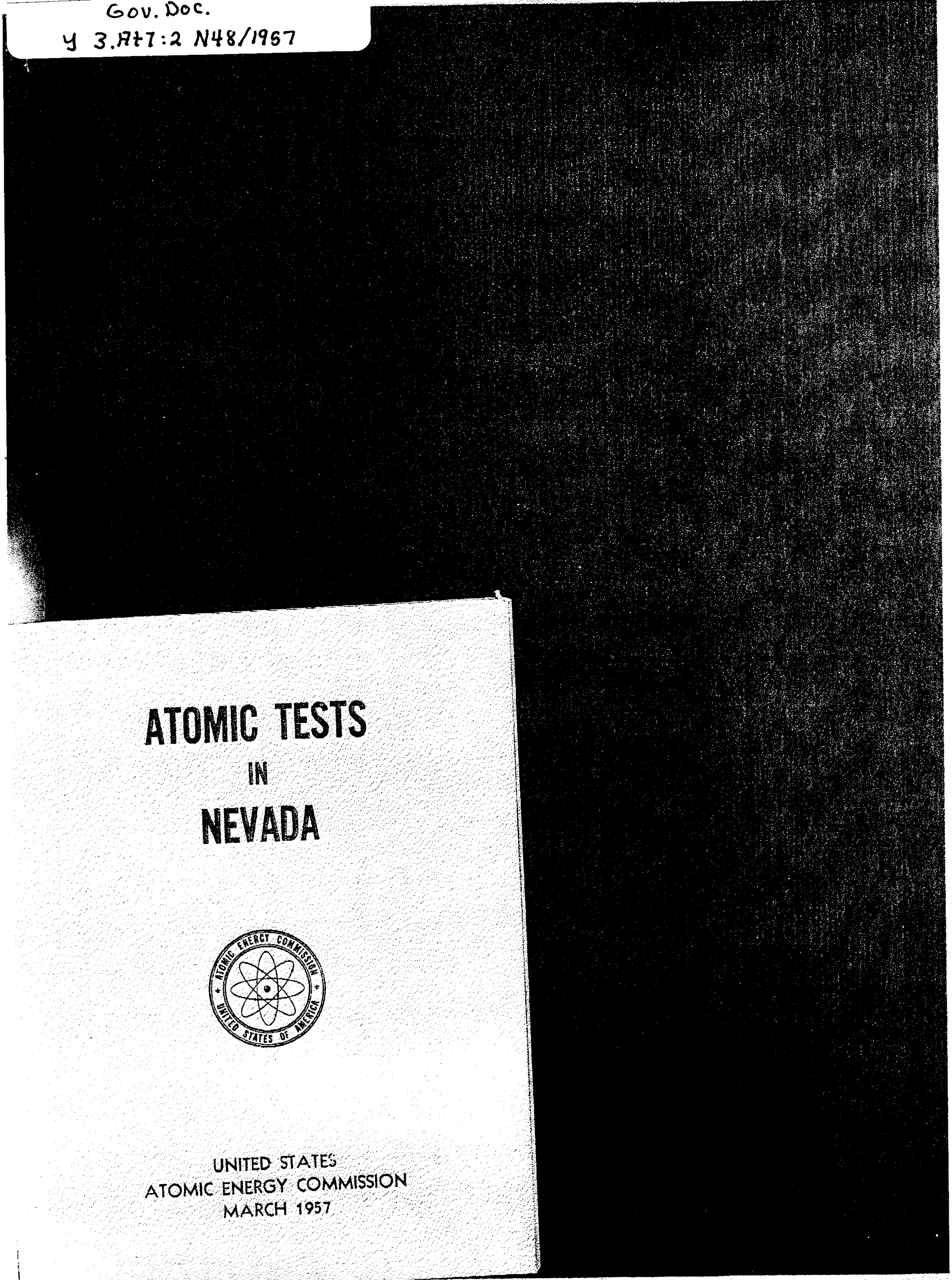

ATOMIC TESTS
IN
NEVADA
ATOMIC ENERGY COMMISSION
UNITED STATES OF AMERICA
UNITED STATES
ATOMIC ENERGY COMMISSION
MARCH 1957

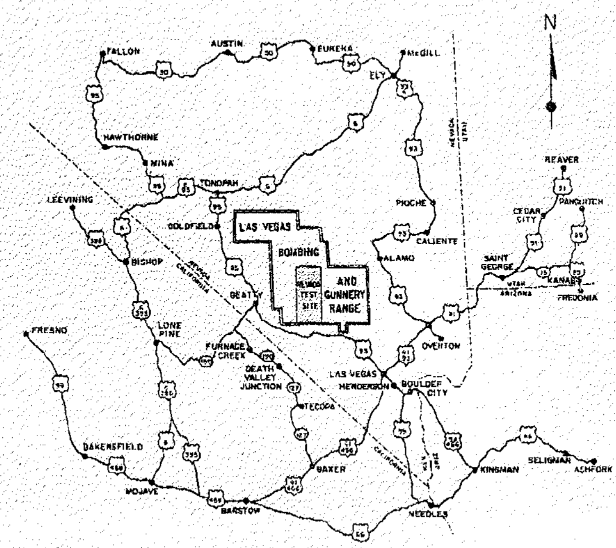
October 23, 1956

". . . until that international trust is firmly secured, we must—and do—make sure that the quality and quantity of our military weapons command such respect as to dissuade any other Nation from the temptation of aggression.

"Thus do we develop weapons, not to wage war, but to prevent war . . . not primarily weapons for vaster destruction—but weapons for defense of our people against any possible enemy attack, as well as knowledge vital to our whole program of Civil Defense. . . .

"We must continue—until properly safeguarded international agreements can be reached—to develop our strength in the most advanced weapons—for the sake of our own national safety, for the sake of all free Nations, for the sake of peace itself."

DWIGHT D. EISENHOWER



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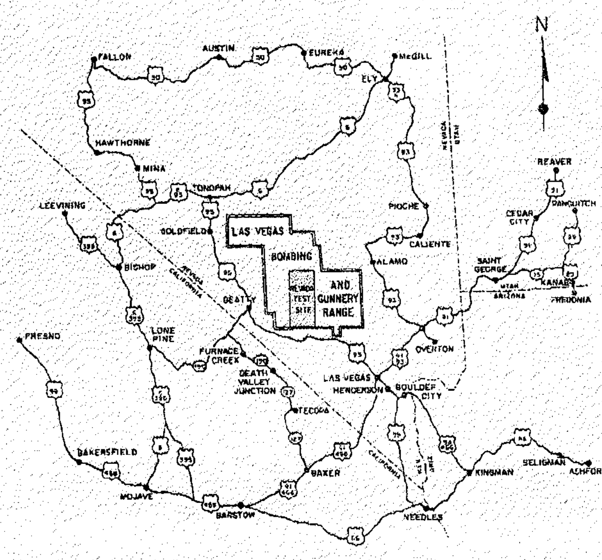


LOCATION OF NEVADA TEST SITE

ATOMIC TESTING IN NEVADA

The Nevada Test Site of the U. S. Atomic Energy Commission is used periodically for experiments or tests involving nuclear detonations of relatively low yield (explosive energy).

Forty-five nuclear fission weapons, weapon prototypes, and experimental devices were fired at the Nevada Test Site from January 1951 to June 1955. They ranged in yield from less than 1 kiloton up to considerably less than 100 kilotons. (A kiloton is equivalent to 1,000 tons of TNT.)

Despite their relatively low yield, Nevada tests have clearly demonstrated their value to all national atomic weapons programs. They have made important contributions to the development of a whole family of weapons, including ones for defense against attack. Because of them our Armed Forces are stronger and our Civil Defense better prepared.

Each test fired in Nevada is justified, before it is scheduled, as to national need for the data sought. Each Nevada test has successfully added to scientific knowledge needed for development and use of atomic weapons, and needed to strengthen our defense against

enemy weapons. Most tests have been used additionally for basic research, such as biological studies, which could be conducted only in the presence of a full scale nuclear detonation.

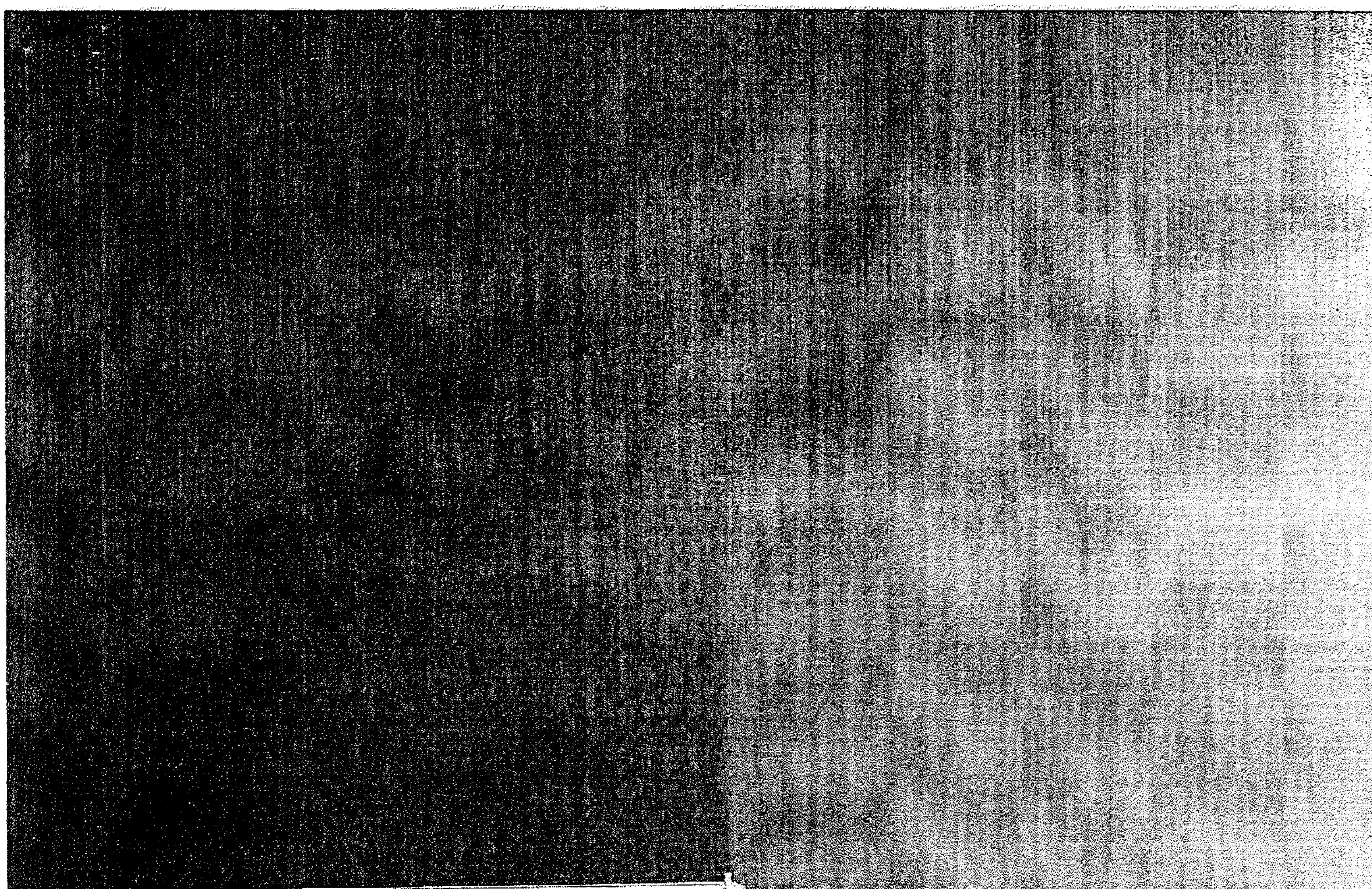
Conducting low-yield tests in Nevada, instead of in the distant Pacific, also has resulted in major savings in time, manpower, and money. The saving of time is particularly important because of its contribution to the Nation's defense capability.

PROTECTION OF THE PUBLIC

You people who live near Nevada Test Site are in a very real sense active participants in the Nation's atomic test program. You have been close observers of tests which have contributed greatly to building the defenses of our country and of the free world. Nevada tests have helped us make great progress in a few years, and have been a vital factor in maintaining the peace of the world.

Some of you have been inconvenienced by our test operations. Nevertheless, you have accepted them without fuss and without alarm. Your cooperation has helped achieve an unusual record of safety.

To our knowledge no one outside the test site has been hurt in six years of testing. Only one person, a



test participant, has been injured seriously as a result of the 45 detonations. His was an eye injury from the flash of light received at a point relatively near ground zero inside the test site. Experience has proved the adequacy of the safeguards which govern Nevada test operations.

Potential Exposure Is Low

Any atomic detonation, even though small enough to be fired in Nevada, involves powerful forces. The effects of a detonation include flash, blast, and radioactive fallout. Your potential exposure to these effects will be low, and it can be reduced still further by your continued cooperation.

The low level of public exposure has been made possible by very close attention to a variety of on-site and off-site procedures.

Public protection began with selection of the site. Nevada Test Site was selected only after extensive studies of other possible locations. The testing site covers an area of more than 600 square miles, with an adjoining U. S. Air Force gunnery range of 4,000 square miles. The controlled areas are surrounded by wide expanses of sparsely populated land, providing optimum conditions for maintenance of safety.

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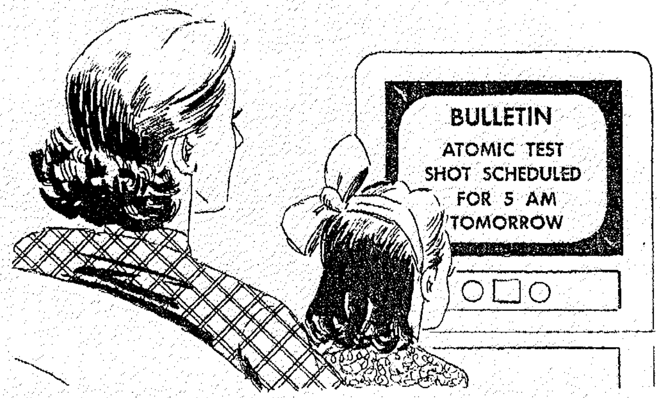
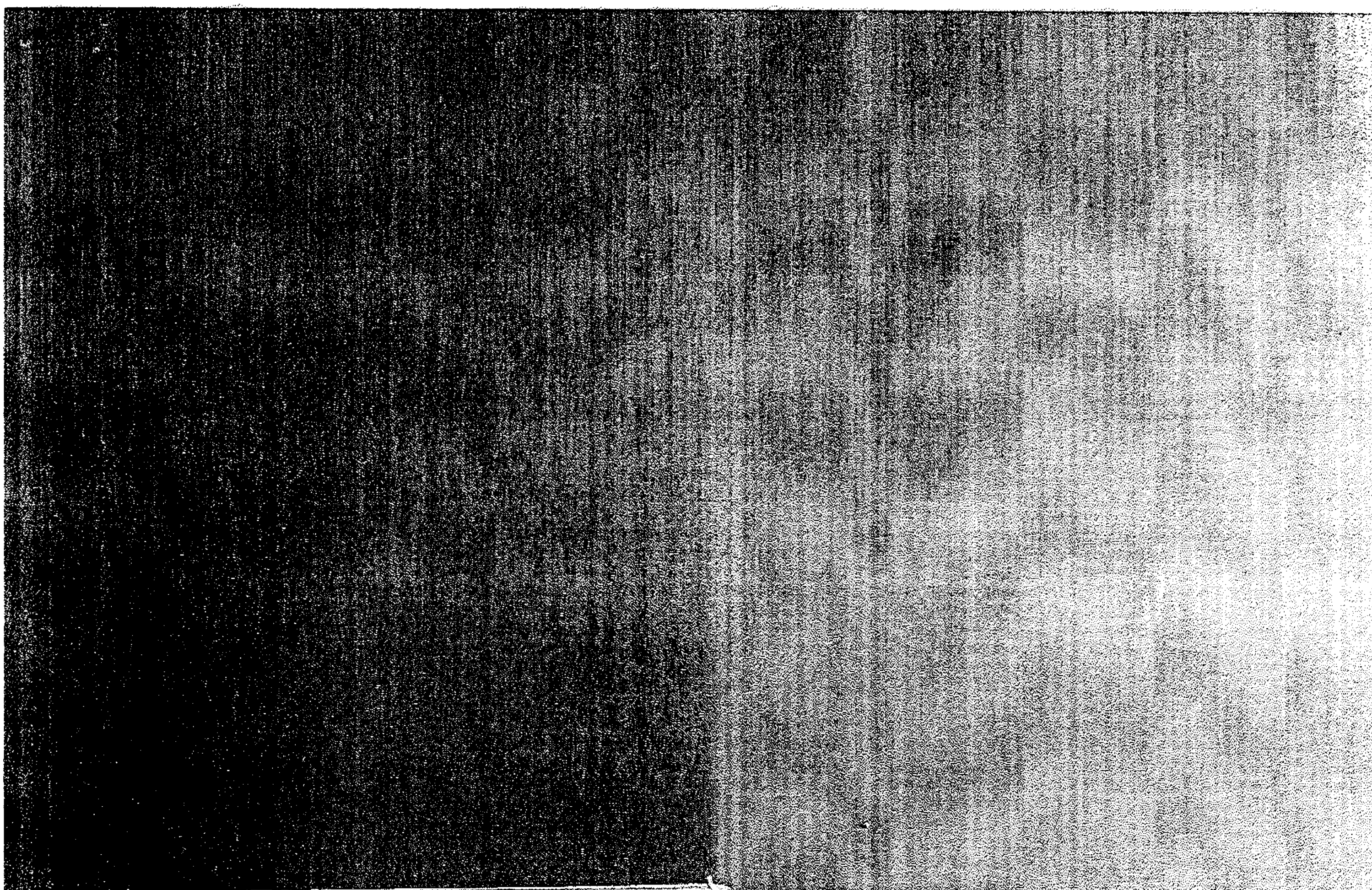


Every Test Is Evaluated

Every test detonation in Nevada is carefully evaluated as to your safety before it is included in a schedule. Every phase of the operation is likewise studied from the safety viewpoint.

An advisory panel of experts in biology and medicine, blast, fallout, and meteorology is an integral part of the Nevada Test Organization. Before each nuclear detonation, a series of meetings is held at which this panel carefully weighs the question of firing with respect to assurance of your safety under the conditions then existing.

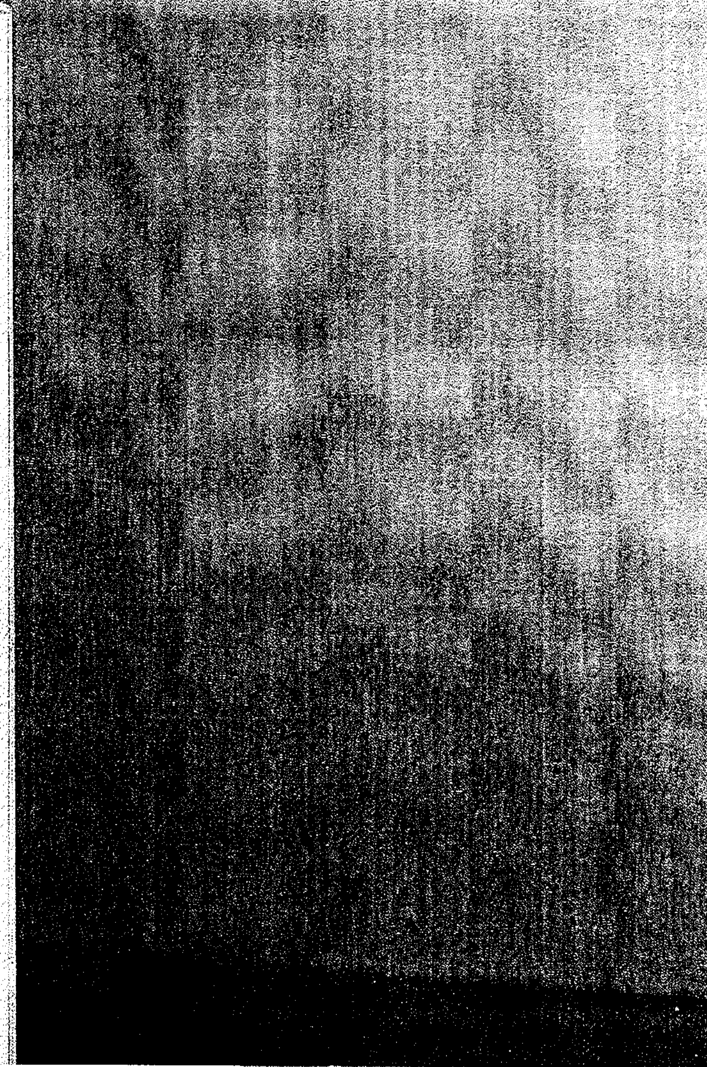


A complete weather unit is operated at the test site, drawing upon the extensive data available from the U. S. Weather Bureau and the USAF Air Weather Service, plus additional weather stations ringing the test site. The data are evaluated up to one hour before shot time. A shot can be canceled at any time up to a few minutes before the scheduled detonation. In past Nevada test series, there have been more than 80 postponements due to forecasts of unfavorable weather at shot time or for the hours immediately thereafter.

Off-site radioactive fallout is the most critical test effect with regard to public health. You who live near the test site know that experience in each series and technical developments have brought improved controls and procedures for each series.

Minimum Exposure Is Goal

Past improvements include: Improved forecasting of wind speed and directions; improved methods of predicting fallout and blast intensity and location, including use of high-speed "electric brain" analog computers; reducing fallout by means such as yield limitations and increasing the height above ground of detonations; and intensified off-site radiological monitoring operations.



There is constant effort to arrive at procedures which, while letting scientists obtain essential data, will reduce public exposure to a minimum.

EFFECTS OF NUCLEAR DETONATIONS

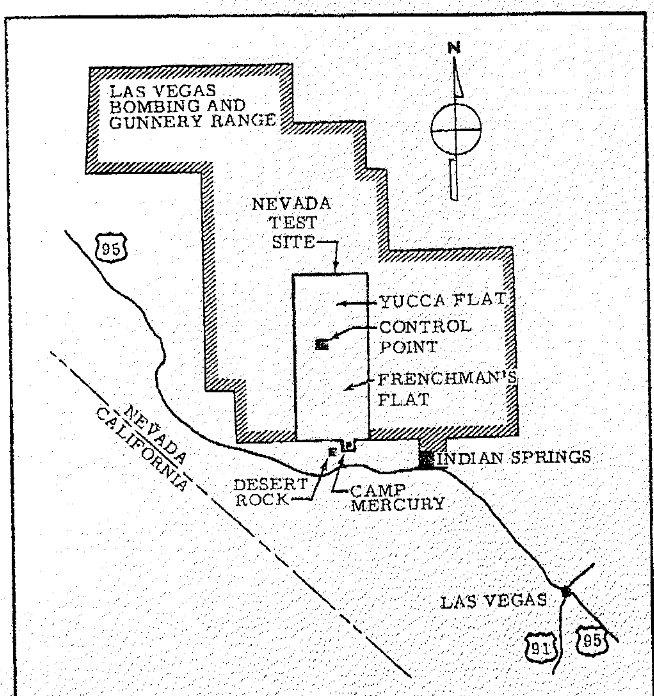
A nuclear explosion releases tremendous energy, equivalent in a so-called "nominal" burst to about 20,000 tons of TNT. This energy is released as heat, light, blast, and nuclear radiation.

The heat energy, released instantaneously, produces very hot gases at a high pressure, and the outward movement of these gases creates a shock wave, which is capable of severe destructive effects in the immediate area.

The instantaneous release of light is so great that devices denotated in Nevada, when fired before dawn, have produced a flash visible 400–600 miles away. At a distance of about 6 miles, the brilliant flash from a 20-kiloton burst—used as an example throughout this section—is 100 times brighter than the sun.

Nuclear radiation is released as particles and waves (similar to X-rays) of energy. A portion of the radiation is released instantaneously in the form of neutrons (particles) and gamma rays (or waves).

The remainder of the radiation is given off over a



NEVADA TEST SITE

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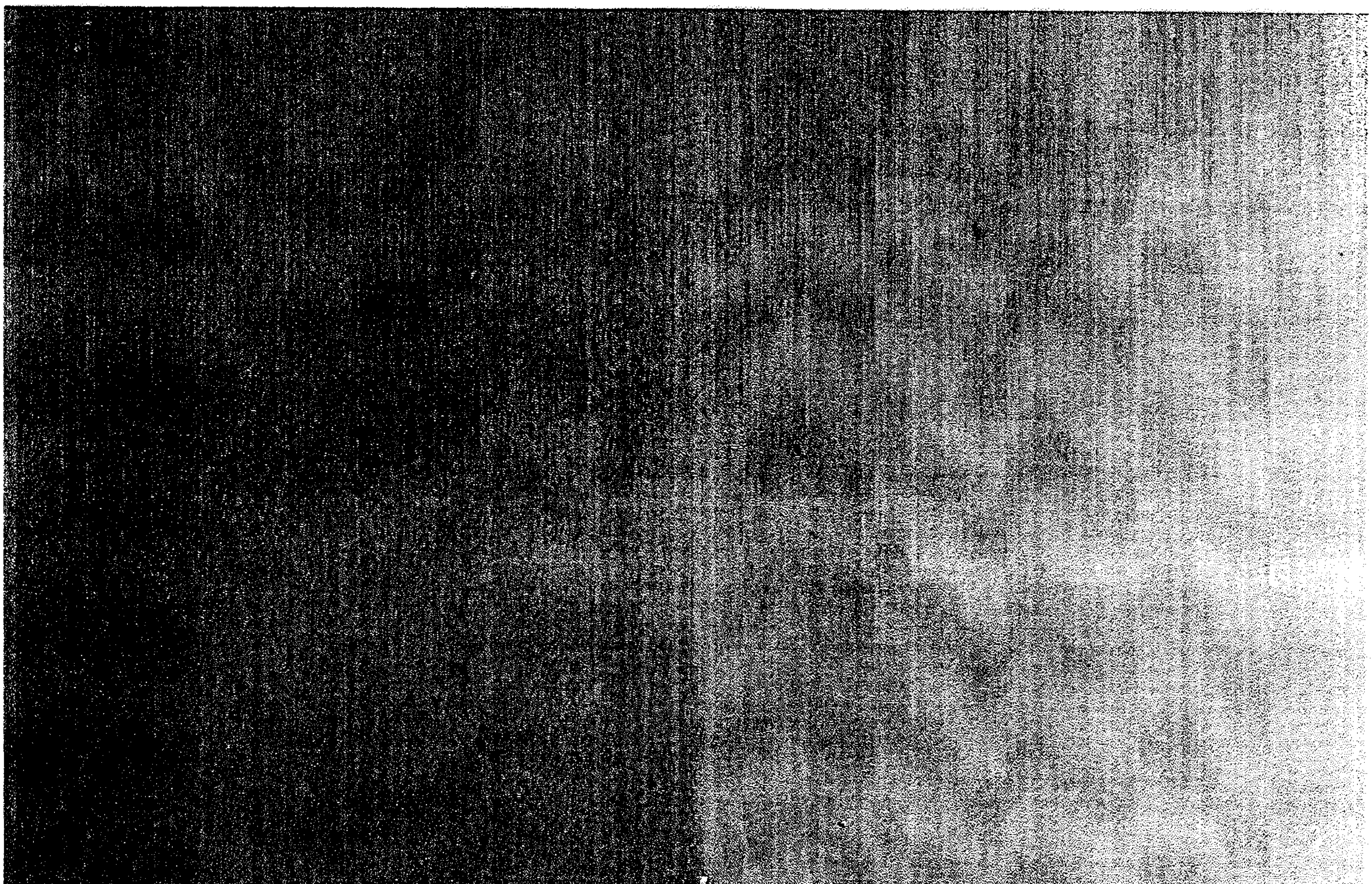
The remainder of the radiation is given off over a

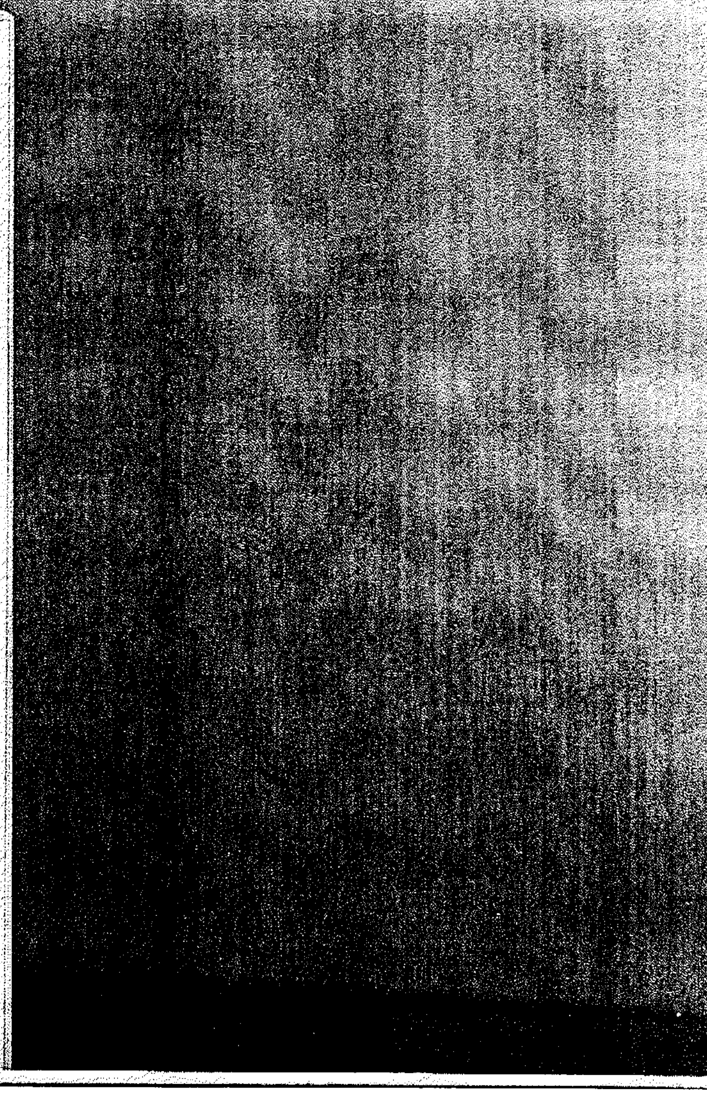
period of time by the "fission products" created during the nuclear detonation.

For each 20 KT of explosive energy, about two pounds of radioactive materials are produced. In these 2 pounds are a variety of different radioactive substances varying in half-life from a fraction of a second to many years.

(To understand radiation and radioactive fallout it is essential to know what is meant by the "half-life" of radioactive materials. The half-life of any radioactive substance is the period in which the radioactivity decreases or decays to one-half of its original value. In the next similar period the remainder again decreases by one-half, and so on until the radioactivity is insignificant.

(For every sevenfold increase in age of the mixture of radioactive materials produced by a nuclear detonation, the total radioactivity is decreased tenfold. Thus, at the end of one hour after the detonation, the radiation level is only 5 per cent of what it was 5 minutes after the burst. At the end of 7 hours, it is only one-tenth the radioactivity of 1 hour, after 49 hours it is one one-hundredth, and after 2 weeks, one one-thousandth.)





Materials Vaporized by Heat

The materials of the nuclear device, the resulting fission products, and materials in any firing platform such as a tower and its cab are vaporized by the heat and become part of the fireball, a luminous sphere which appears as the air is heated to temperatures approaching a million degrees centigrade. A radioactive cloud is formed by cooling of the fireball. Many of the radioactive materials in the cloud are nonvolatile and will settle upon the first solid surface which they contact. In this way, they settle upon the solid particles formed by condensation of the bomb materials and any other materials drawn into the fireball.

As it rises, the fireball may draw up small amounts of dust from the ground (in an aerial burst) or very large amounts (if the fireball touches the ground). Such material may be made slightly radioactive by the neutrons, but, more important, it serves as an important means for carrying the radioactive fission products back to the ground.

Light, Shock Pass Quickly

One second after detonation, the fireball from a nominal 20-kiloton burst reaches its maximum apparent radius of about 600 feet and begins to rise like a gas

balloon. Its average rate of climb in the first minute is about 250 feet per second.

By the end of 10 seconds, the intense luminosity of the fireball has almost died out, the shock wave has traveled 12,000 feet and passed the region of heavy damage, and formation of the cloud has begun. The immediate effects of the explosion have run their course, leaving only the delayed effects of residual radiation and the possibility of more distant air blast effects.

The cloud, containing radioactive oxides of fission products and more or less dirt and debris, depending upon the conditions of the test, rises high into the air. The base of the cloud's stem settles back onto the firing area, while the cloud itself is carried away and dispersed by winds.

Neither heat nor the immediate nuclear radiation is hazardous outside of the general firing area of the test site. Beyond about 7,000 feet the immediate nuclear radiation from detonation of a nominal-yield device is virtually harmless. The heat is noticeable at 10 miles only as a wave of warmth.

The other three effects of an atomic explosion—light, blast waves, and residual radioactivity which falls from the cloud to the ground—can present a safety

hazard outside the test site under certain conditions. These effects will be discussed in more detail.

FALLOUT FROM NEVADA TESTS

We cannot see, feel, smell, taste, or hear nuclear radiation. Consequently it may seem to be more difficult to understand than are light and sound waves from Nevada tests.

In order to help you understand radioactive fallout, we have appended to this booklet a discussion of the units used in measuring radiation, natural radioactive background, and the effects of radiation on man, including possible effects on inheritance and life expectancy.

Please understand that in the following discussion of radioactive fallout, we are not talking about high-yield A-bombs or H-bombs tested elsewhere. We are not talking about radiation from enemy bombs designed to do the most damage possible. We are talking only about low yield tests, conducted under controlled conditions at Nevada Test Site.

The Atomic Cloud

As the fireball rises, the atomic cloud forms. If dirt and debris have been drawn up into it, they become

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coated with radioactive materials and immediately start falling to earth. As the cloud rises, it expands, begins losing its radioactivity by decay, and floats away.

The radioactive particles within the cloud are initially of a wide range of sizes. Extremely small particles are apt to be fission products; larger particles are more likely to consist of fission products condensed on dust and debris of the air or sucked up from the ground.

As the radioactive particles begin to descend to earth, they are carried transversely by the winds. The larger

particles tend to settle first. Fallout—the descent of the particles back to earth—may occur in the immediate vicinity of the burst or thousands of miles away.

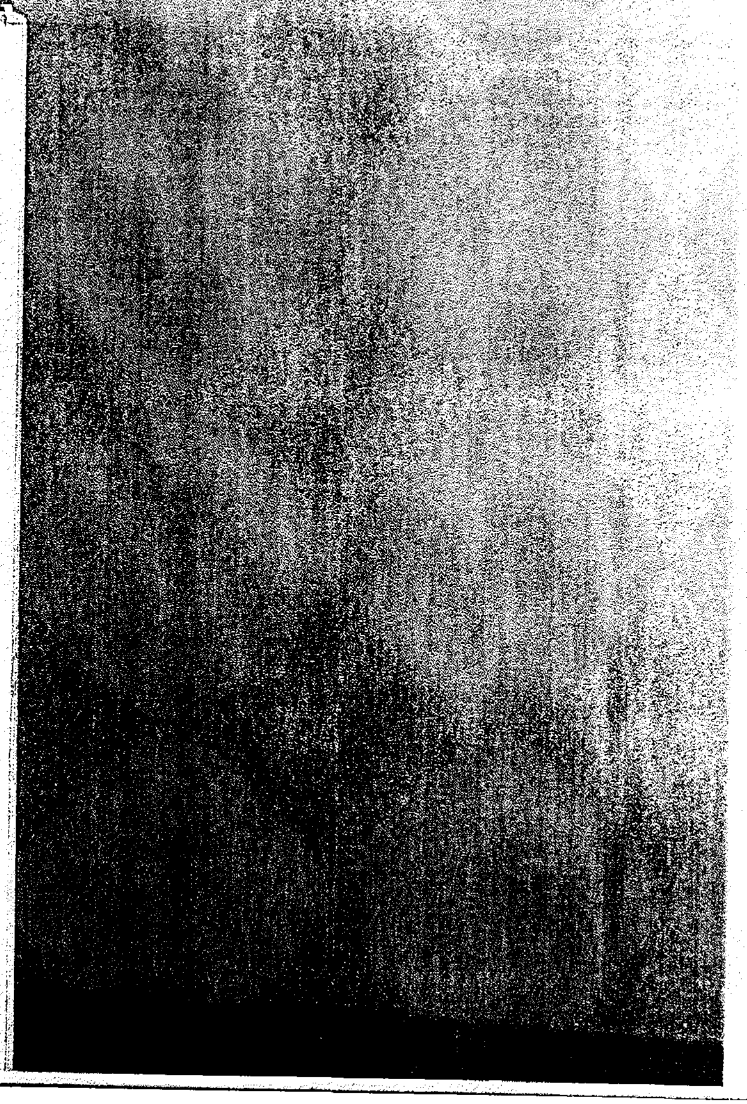
Heaviest Fallout Close-in

The heaviest fallout of radioactive particles is in the firing area. The area of quite heavy fallout may extend several miles from ground zero, but it has not extended outside the controlled area of the Las Vegas Bombing and Gunnery Range. This is one reason people are kept away from the test site and bombing range during tests.

As the main cloud, or its segments, moves along it becomes dispersed and usually within a few hours is no longer visible, having spread into one or more diffused air masses.

Even though the cloud becomes an invisible air mass, it can be traced by the trail it leaves in the air and on the ground somewhere beneath it. This trail is of radioactive particles which fall from the cloud and can be detected and measured by highly sensitive instruments.

The fallout path generally is narrow at the test site and in the nearby region, and disperses to a width of hundreds of miles as it moves on. For a Nevada

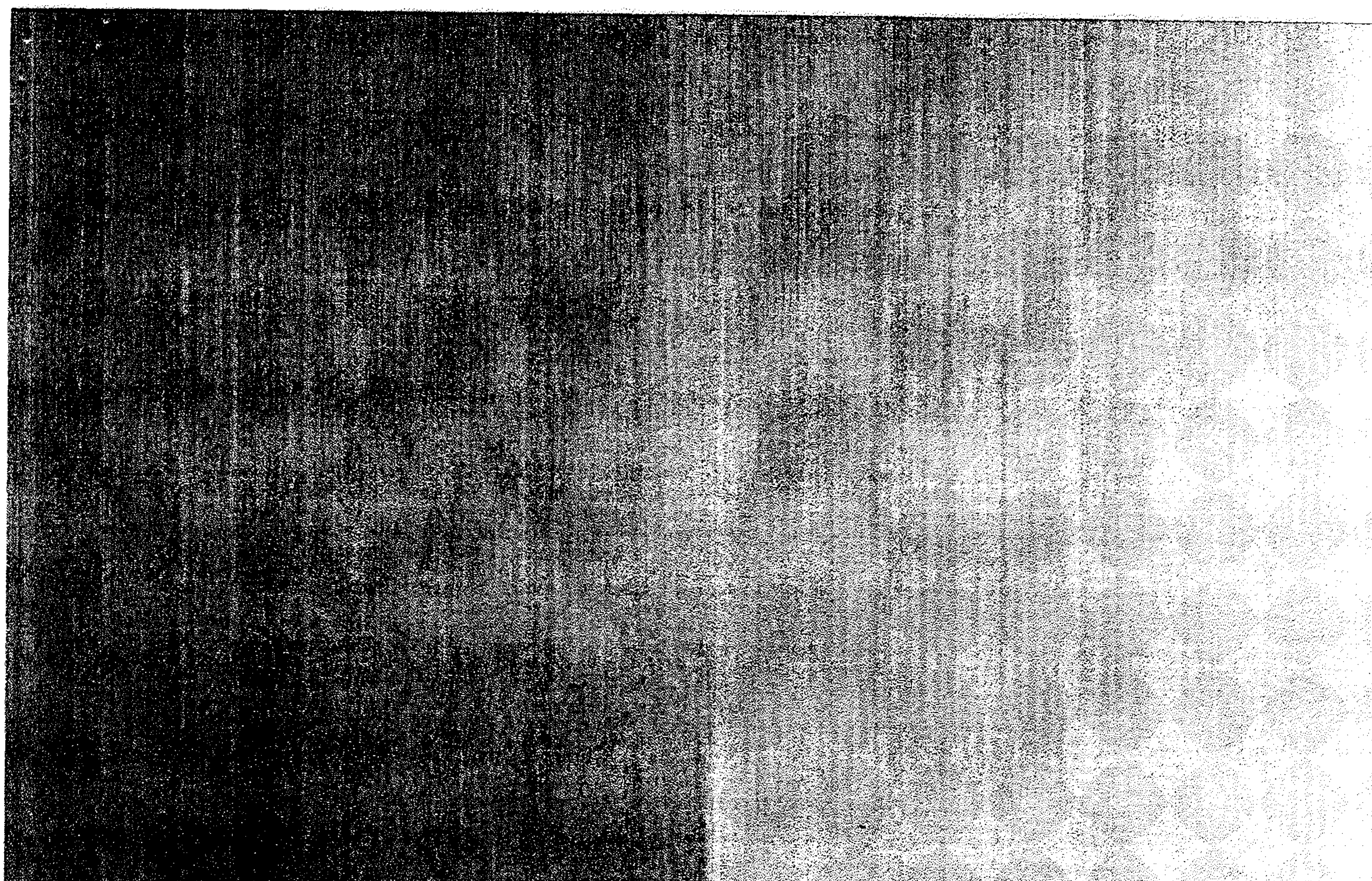


shot the air mass containing fission particles remains within the troposphere, which is the atmospheric layer extending from the earth's surface up to about 6 miles. Some particles may make two or three trips around the earth in a given latitude before being entirely removed by the action of precipitation, gravity and atmospheric turbulence, with rain and snow the most important factors. Virtually all such radioactive particles are removed in a matter of weeks.

Fallout Experience in Past Tests

We are now able to summarize fallout findings for a 6-year period, January 1951 to January 1957, covering five test series, and so to pinpoint the degree of possible hazard or inconvenience created by Nevada tests.

The Nevada Test Organization uses various procedures to record promptly the actual fallout in the nearby region so that any needed action can be taken to reduce exposure, and so you may be told the level of exposure you may have experienced if you were in the fallout path. Fixed recording stations, mobile monitoring teams, low-flying aircraft which measure ground-level radiation, and planes which track the atomic air mass are all used.



Thousands of reports are made. The instrument readings are translated into roentgens of whole body gamma exposure in terms of "effective biological dose," which estimates the greatest probable exposure a permanent resident would receive at that location. (The roentgen is a unit used in measuring radiation.) In the spring 1955 series, thousands of film badges were placed throughout the nearby region on individuals and on buildings. They recorded accumulated exposure, and the results confirmed the prompt public reports made from instrument readings.

Simply stated, all such findings have confirmed that Nevada test fallout has not caused illness or injured the health of anyone living near the test site.

This was confirmed also by a spokesman for the National Academy of Sciences during a press conference in June 1946 on the results of a study of the biological effects of atomic radiation by 145 outstanding scientists. (See Appendix.) He was asked how fallout on communities around the test site compared with the NAS-recommended figures and replied: "The off-site exposure guides are regarded as safe, and there is no area that has exceeded the safe level."

"1946" above should read "1956"

Summary of Six-Year Exposure Levels

The following table contains estimates of the effective biological doses which might have been experienced by residents of the communities and small cities in the Test Site region during the entire six-year period since nuclear tests began in Nevada.

Gamma radiation exposures received by persons in a given locality tend to vary considerably from individual to individual. The whole body exposure received by a person depends upon a number of factors, including the amount of time the individual spends in sheltered areas, such as indoors, and the rate at which the radioactivity is decreased by conditions in addition to radioactive decay, such as weathering. Thus, estimates of effective biological dose for residents of a community, such as those listed in the table below, are conservative; that is, they fall near the high end of the range of possible doses.

UTAH

	roentgens		roentgens
Alton	0.8 r.	Beryl Junction	1.0 r.
Anderson Junction	1.2 r.	Cedar City	0.4 r.
Bear Valley Junction	0.4 r.	Enterprise	0.7 r.
Beaver	0.25 r.	Garrison	0.7 r.
Beryl	0.5 r.	Glendale	1.2 r.

UTAH—Continued

	roentgens		roentgens
Gunlock	2.6 r.	Panguitch	0.2 r.
Hamilton Fort	0.6 r.	Paragonah	0.4 r.
Hurricane	4.2 r.	Parowan	0.4 r.
Kanab	1.6 r.	Pintura	1.2 r.
Kanarraville	1.2 r.	Rockville	3.0 r.
Leeds	3.0 r.	Saint George	3.0 r.
Long Valley	0.8 r.	Santa Clara	3.5 r.
Lune	0.5 r.	Shivwits	2.8 r.
Milford	0.1 r.	Springdale	2.6 r.
Minersville	0.2 r.	Toquerville	2.0 r.
Modena	0.5 r.	Veyo	2.0 r.
Mount Carmel	0.85 r.	Virgin	1.5 r.
New Castle	0.6 r.	Washington	3.0 r.
New Harmony	1.2 r.	Zane	0.3 r.
Orderville	1.5 r.		

NEVADA

	roentgens		roentgens
Acoma	3.0 r.	Boulder City	0.08 r.
Alamo	1.3 r.	Buckhorn Ranch	0.9 r.
Apex	0.1 r.	Bunkerville	4.3 r.
Ash Meadows	0.05 r.	Cactus Spring	0.03 r.
Ash Springs	0.6 r.	Caliente	0.7 r.
Austin	0.05 r.	Carp	3.6 r.
Baker	0.8 r.	Charleston Lodge	0.15 r.
Barclay	2.0 r.	Clarks Station	0.8 r.
Beatty	0.05 r.	Crestline	0.7 r.

NEVADA—Continued

	roentgens
Crystal	4.0 r.
Crystal Springs	1.0 r.
Currant	0.5 r.
Camp Desert Rock	0.05 r.
Dry Lake	1.0 r
Duckwater	0.8 r.
East Ely	0.6 r.
Eden Creek Ranch	0.7 r.
Elgin	3.5 r.
Ely	0.6 r.
Eureka	0.2 r.
Fallini Ranch	0.8 r.
Glendale	0.7 r.
Goldfield	0. to 0.015 r.
Groom	2.0 r.
Henderson	0.02 r.
Hiko	1.0 r.
Hoover Dam	0.05 r.
Indian Springs AF Base	0.05 r.
Johnnie	0
Kimberley	0.5 r.
Lake Mead Resort	0.05 r.
Las Vegas	0.2 r.
Lathrop Wells	0.05 r.
Lincoln Mine	4.0 r.
Lockes Ranch	1.3 r.

	roentgens
Logandale	0.4 r.
Lund	0.8 r.
Camp Mercury	0.1 r.
Mesquite	1.8 r.
McGill	0.4 r.
Moapa	0.8 r.
Nellis AF Base	0.05 r.
North Las Vegas	0.2 r.
Myala	1.7 r.
Overton	0.35 r.
Pahrump	0.2 r.
Panaca	0.65 r.
Pioche	0.7 r.
Preston	0.7 r.
Reed	4.0 r.
Round Mountain	0.05 r.
Rox	3.0 r.
Ruth	0.5 r.
Sharp's (Adaven)	1.2 r.
Shoshone	0.7 r.
Springdale	0.02 r.
Sunnyside	1.2 r.
Tonopah	0 to 0.015 r.
Ursine	0.6 r.
Warm Springs	0.5 r.
Warm Spring Ranch	1.0 r.
Whitney	0

ARIZONA

	roentgens		roentgens
Beaver Dam	2.0 r.	Peach Springs	0
Kingman	0.03 r.	Short Creek	1.6 r.
Littlefield	1.6 r.	Wolf Hole	1.3 r.
Mt. Trumbull	0.16 r.		

In addition to these communities, fallout occurred in 1953 at a motor court near Bunkerville, Utah, where about 15 people might have accumulated 7–8 roentgens if they had continued to live there. This was the highest fallout level noted to date in the United States in an inhabited place outside of the test site.

Fallout recorded at any other inhabited location within 200 miles of Nevada Test Site has been so low as to be insignificant.

Beta Rays

If highly radioactive fallout particles are deposited on or very near the surface of the skin, as on clothes or hair, and stay there for an appreciable period, beta radiation can cause hair loss, skin discoloration and burns. Beta burns appear similar to burns produced by heat, except that they appear only after about 2 weeks and heal slowly and more imperfectly. Beta particles can barely penetrate the skin and produce

no other damage if not taken into the body by breathing or swallowing.

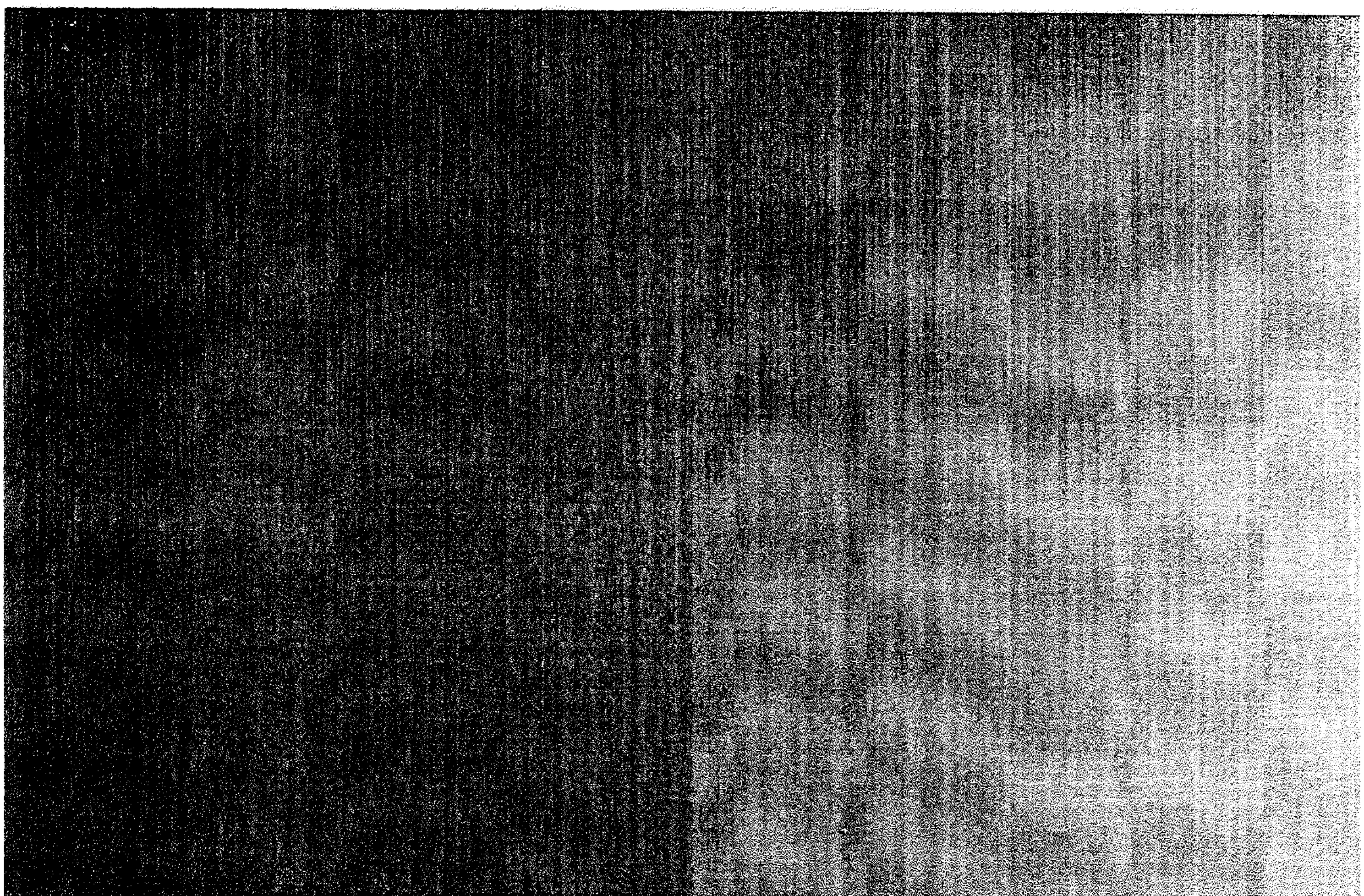
Because fallout consists of small particles, it cannot be guaranteed that a small beta burn would never occur to a person living near the test site. Extensive investigation, however, has failed to disclose any such instance as a result of past tests. It is considered highly improbable that there would be such an instance when whole-body exposures are as low as those listed above.

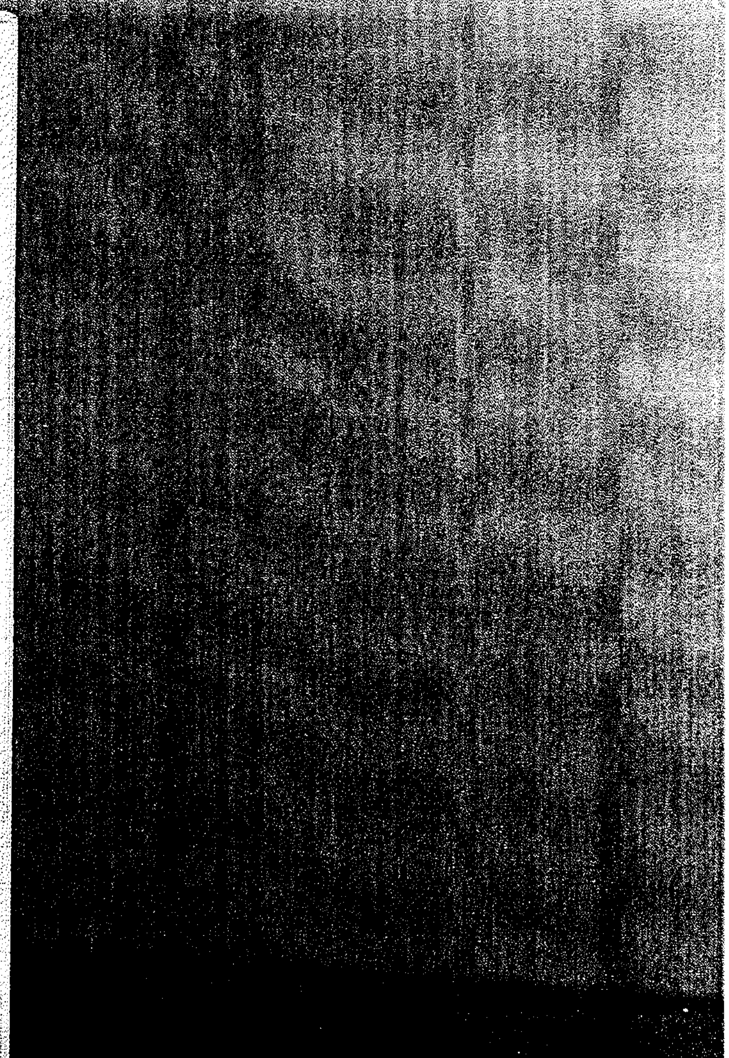
The only beta burns recorded from Nevada tests have been on the skin of some cattle and horses grazing within 20 miles of the firing area. There was no damage to the breeding value or the beef quality of the cattle.

Simple decontamination measures, such as bathing and changing clothes, effectively reduce the possibility of beta burns.

Radioactive Strontium

Radioactive materials may be taken into the body by breathing or swallowing. A radioactive form of strontium, Strontium-90, is the most important constituent of fallout from the standpoint of internal radiation exposure. Because of a combination of characteristics (explained in the Appendix) Strontium-90 tends to





stay in the body and to emit beta rays for a long period of time.

The dissemination of Strontium-90 from nuclear detonations and its uptake by human beings have been under study by the Commission since 1948. Thousands of measurements of Strontium-90 in the atmosphere, the soil, food materials and the skeletons of animals and human beings have been made, not only in the test site region, but elsewhere in the United States and in other parts of the world.

> None of these measurements has shown a hazardous concentration of Strontium-90. All are below the permissible concentration for Strontium-90 recommended by the National Committee for Radiation Protection, an authoritative body which recommends standards of radiation exposure.

Distant Fallout

Outside the test site region, the U. S. Atomic Energy Commission, the U. S. Weather Bureau and the U. S. Public Health Service monitor fallout radioactivity across the United States and in other parts of the world. Exposure levels are reported periodically.

The range in values of maximum possible accumulated gamma doses to date for localities in the United States outside of the test site region is 0.006 to 0.049 roentgen (except for three cities—Albuquerque, N. Mex., with 0.11; Grand Junction, Colo., 0.12; and Salt Lake

City, Utah, 0.16). Fallout levels outside the United States generally have been even less.

These exposures are small fractions of the exposures which persons receive from natural radioactivity in the environment, and of the average exposures which persons receive from the medical use of radiation.

Fallout Can Be Inconvenient

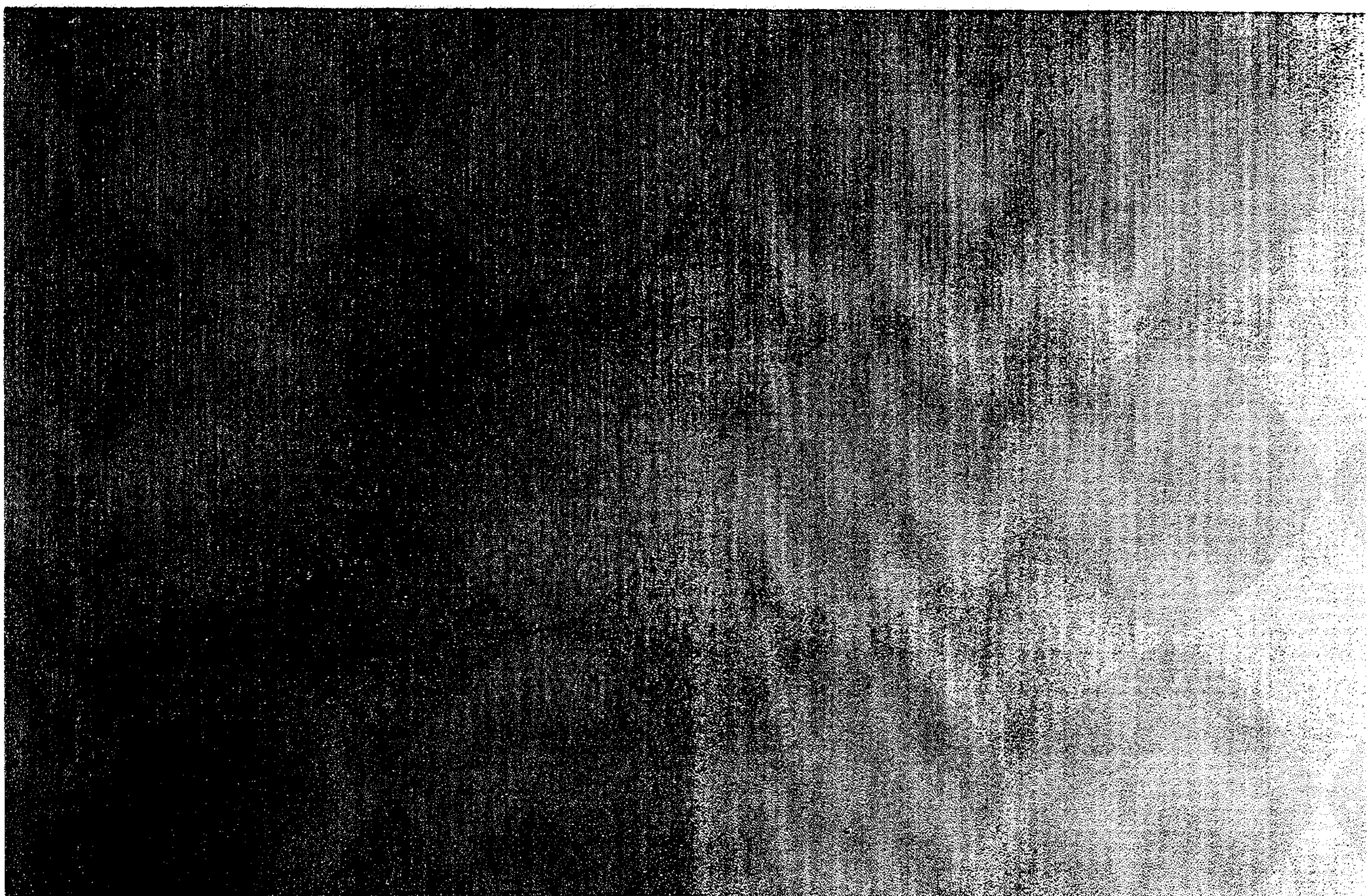
Fallout of very minute intensity can interfere temporarily with some industrial and research enterprises not only near the test site but elsewhere in the United States.

Interference in normal operations may occur in the uranium prospecting and mining business, in industrial and commercial processes where there are radiation controls, in the photographic industry, in low-level radiation research, etc.

Similar interference is, of course, caused by any United States or foreign tests. To help avoid or reduce such interference, Nevada series and individual shots are publicly announced.

Effect on Mining

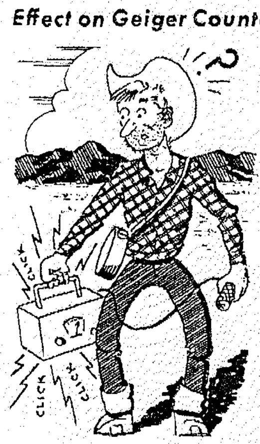
Numerous mines in the test site region produce uranium. Their ventilation systems may draw air—and fallout—into the mines. Temporary levels of radiation from



fallout in the mines may exceed the levels established for normal, day-to-day operations, and still be far from hazardous. Levels in a mine day after day must be low because miners may be exposed to these levels over long periods. The increases caused by fallout last for only a few days.

Many persons in Nevada, Utah, Arizona, and nearby California have Geiger counters these days. We can expect many reports that "Geiger counters were going crazy here today." Reports like this may worry people unnecessarily. Don't let them bother you.

Effect on Geiger Counters



Geiger counters are designed to detect radiation of very low intensity. Most register only as high as 20 milliroentgens (twenty one-thousandths of one roentgen) an hour. A Geiger counter can go completely off-scale in fallout which is far from hazardous, although the fallout might make prospecting difficult for a few days.

Factors Affecting Fallout

The amount of fission products in the cloud depends essentially upon the yield and nature of the nuclear device. The amount of radioactive debris depends on the materials in the device and, if it was mounted on a fixed platform, the amount and nature of materials in that platform (such as a steel tower and its cab), and upon the amount of surface dirt and debris drawn up into the cloud. Where the particles will fall depends on their size, on wind speeds and direction, and on whether there is rain or snow.

The key formula determining particle sizes and amount of radioactive debris is the yield, which determines the radius of the fireball, versus the height of detonation. The area of contamination cannot be forecast without specifying the degree of contact of the fireball with the surface of the earth.

Fireball Radii Given

The radius of the fireball varies with yield. The apparent radius of a 20 KT burst is something like 600 feet. Application of an arithmetical scaling formula gives the following approximate apparent radii for other yields: 2 KT, 240 ft.; 5 KT, 345 ft.; 10 KT, 450 ft.; 15 KT, 540 ft.; 40 KT, 800 ft.; 60 KT, 930 ft.; and

80 KT, 1040 ft. Devices of these yields will not pick up large amounts of surface material when fired at heights greater than the fireball radii.

Fallout From Surface and Near-Surface Bursts

A shallow underground or a surface burst will result in relatively large amounts of radioactive debris. However, if the yield is held to extremely low kiloton figures and the test is made only under conditions of very light low-level winds, almost all the radiation will fall on the test site or the adjacent bombing range.

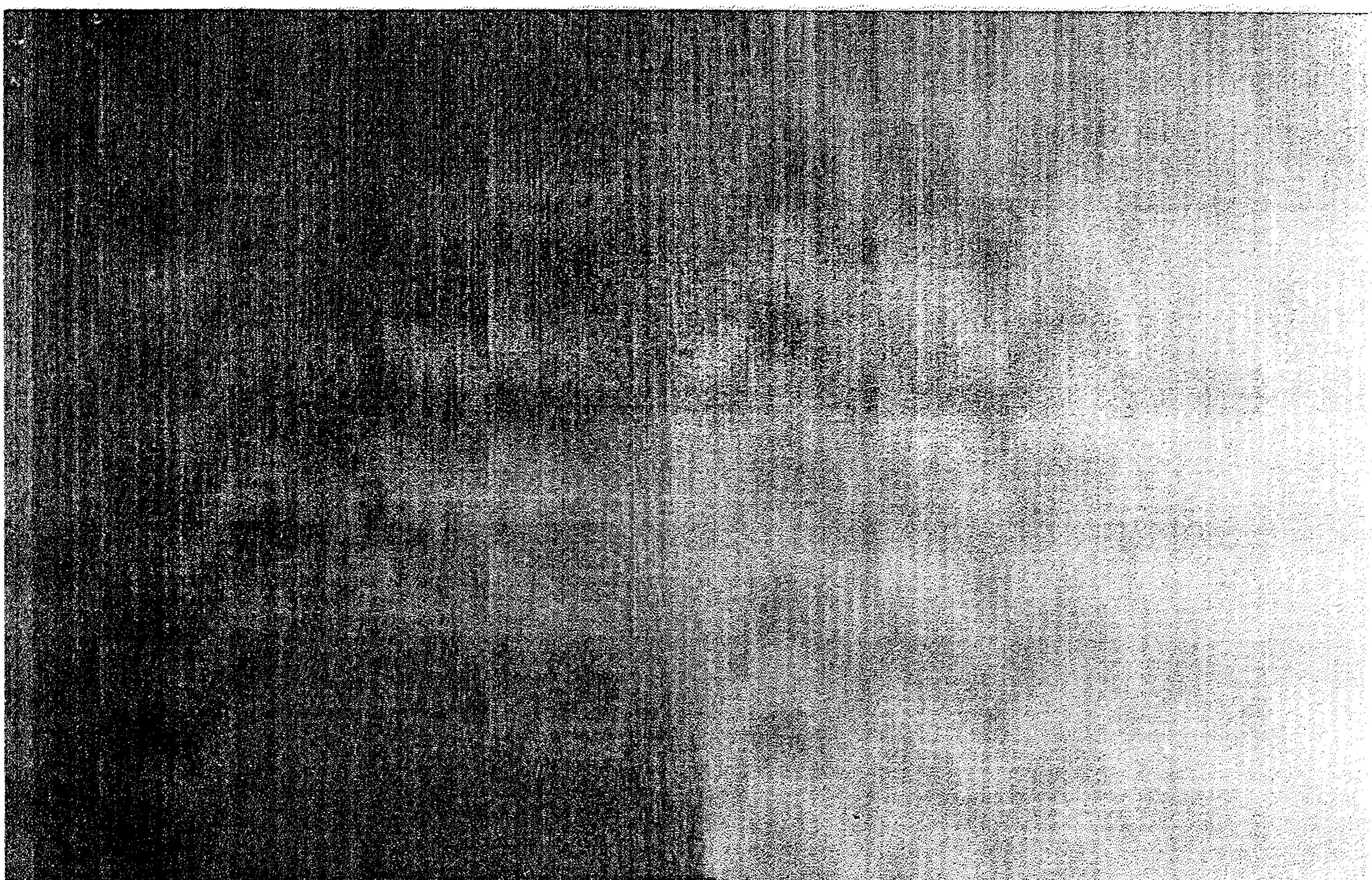
Most Nevada shots have been above the ground—on towers, dropped by aircraft, or fired from a cannon. If the height is such that large quantities of dirt are drawn into the fireball, many of the particles are so heavy they fall rapidly before their radioactivity has decayed significantly. The result is heavy fallout on the test site and adjacent bombing range, and considerable fallout at further distances. The intensity and location of the off-site fallout in nearby regions will depend entirely on the speed and directions of the winds at various altitudes. Slow winds, providing an opportunity for fallout of all heavier particles on open ground, and winds from varying directions to scatter the airborne radioactive debris are necessary, and we wait for them on such shots.

In cases where the fireball from a tower shot does not touch the ground, the mixing of fission products with the material in the tower will cause a few per cent of the radioactive fission products to come down as close-in fallout, although the debris will of course be much less because of the absence of surface dirt.

Fallout From Air Bursts

If the burst of a bomb drop occurs high enough in the air so the fireball does not reach close to the ground, the radioactivity condenses only on solid particles from the bomb casing itself and the dust which is already in the air. Under these conditions, the radioactive fallout particles are very small and descend extremely slowly—in the absence of rain or snow—so that the major part of their radioactivity is dissipated harmlessly in the atmosphere and the residual radioactivity is widely dispersed.

After air bursts in Nevada, fallout in the nearby off-site region has been extremely light, approximating that which occurs anywhere else in the United States. The major operating consideration for such detonations is not wind direction, but the absence of snow or rain in a downwind direction during the early hours after the detonation, while radioactivity is decreasing most rapidly.



Some tests, however, require exact timing to a thousandth of a second and exact positioning to fractions of inches, and may require that instruments be placed close to the device—so that scientists may learn what happened inside the device as it detonated. For such tests, metal towers have been necessary.

Increasing the height of towers helps to reduce fallout, and in the 1955 series they were extended from 300 to 500 feet. Such height required very strong steel towers, and the large quantity of metal used became part of the radioactive debris, offsetting under some circumstances much of the advantage of greater height.

Operating Criteria and Controls

Every practical control or procedure is followed to keep off-site fallout at a minimum level. Technical developments which will reduce fallout and still permit scientists to obtain the essential data are adopted as soon as they can be proven.

The basic goal is to keep off-site fallout as near zero as is possible. Test officials would not approve a shot if they knew that resulting fallout on any community would be heavy. Wind directions and speeds at shot time and for several hours downwind thereafter can be forecast only to within several miles. A minor varia-

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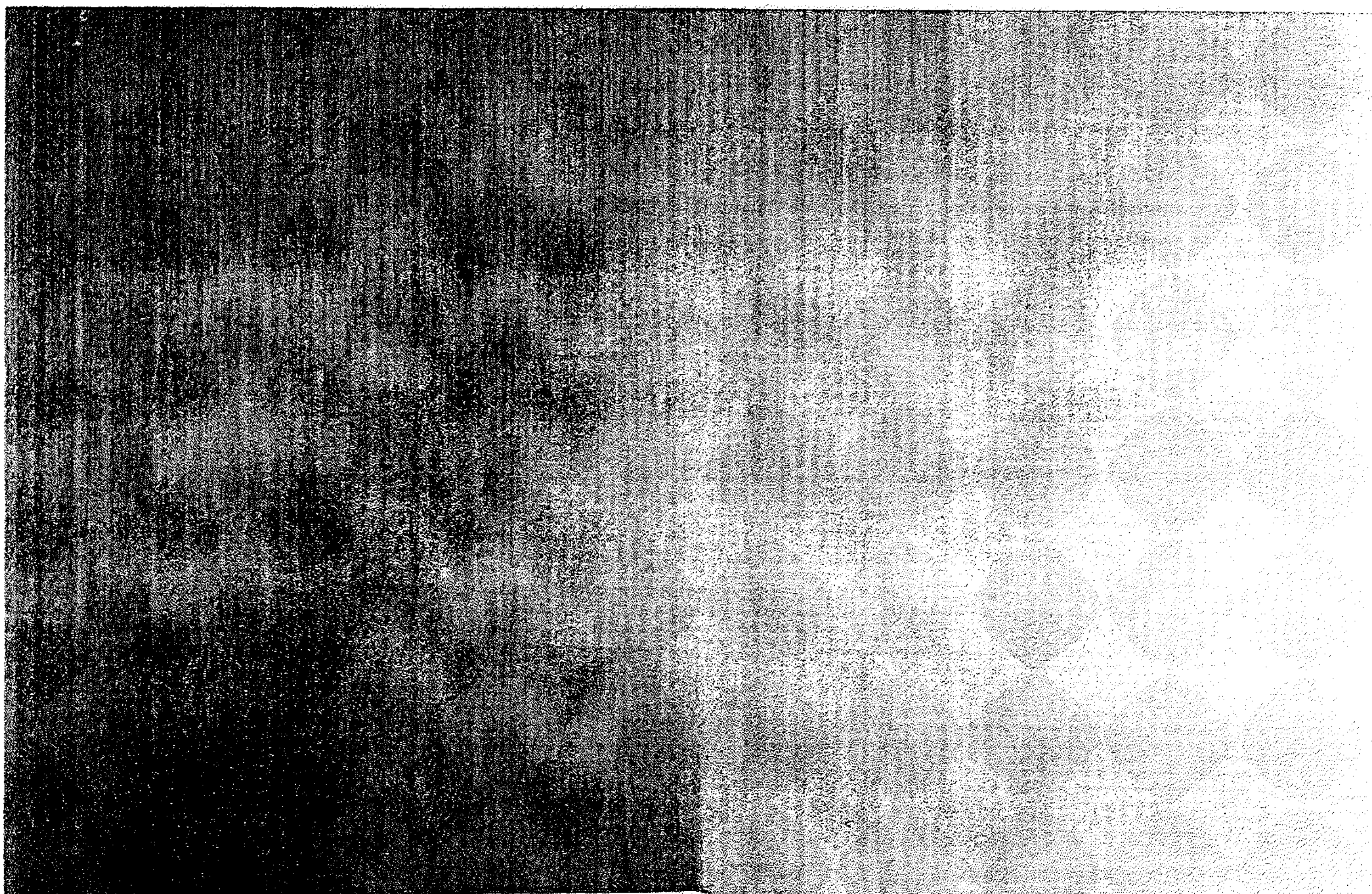
tion in wind direction at any level up to the top of the cloud might cause more fallout than was forecast for a locality. Test personnel must anticipate that there may be some fallout on communities located generally downwind. To guide test management in evaluating a shot and to assure public health protection, the Commission has established an exposure guide for whole body radiation exposure off-site.

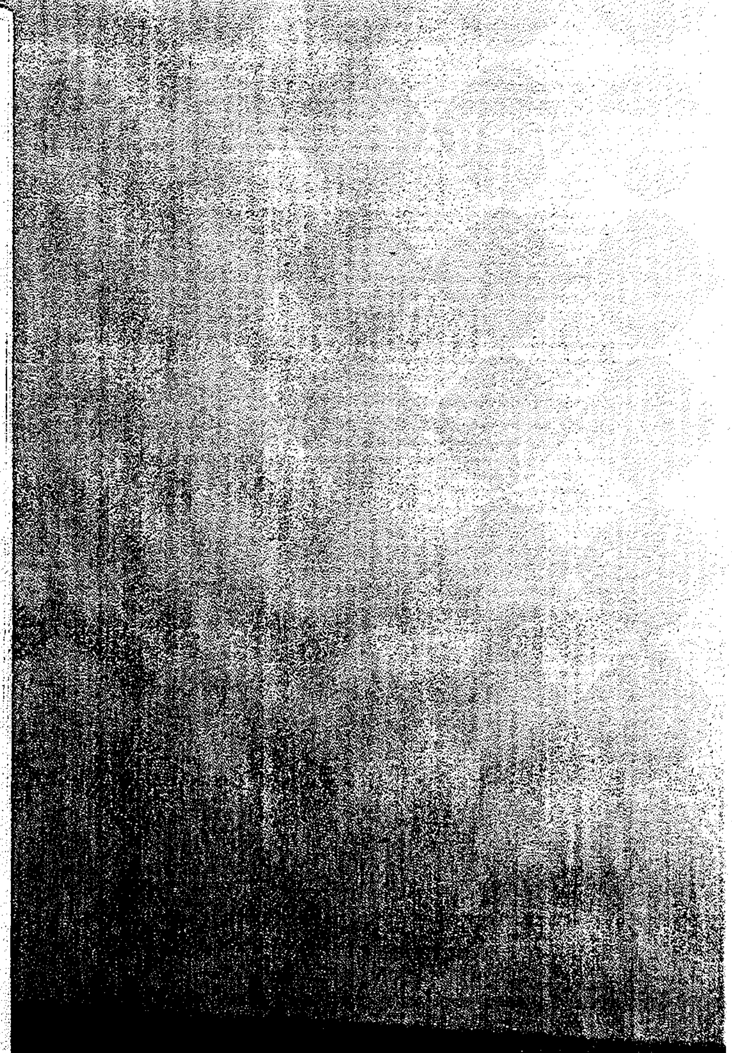
Guides for Off-Site Exposure

The guide for off-site exposure resulting from the 1957 test series is that the entire series should not result in a total exposure to any person exceeding 3.9 roentgens. This is essentially the same standard used in previous Nevada test series.

The 3.9 roentgens standard is not a level of exposure intended to be reached. The test organization will endeavor to keep fallout as near zero as possible. It also should be emphasized that the 3.9 roentgens is not a safety limit. Should a single exposure exceed this figure, it would not necessarily mean that the individuals concerned had been injured.

Scientists and other test participants in Nevada will use a guide of 3 roentgens in 13 weeks and 5 roentgens in a year, although they infrequently may be exposed





to somewhat higher doses because they must go into firing areas after a detonation.

Working backward from the criteria for safe off-site public exposure, test management establishes the operating controls required. Its governing policy is that no shot will be permitted at the Nevada Test Site if it presents an unacceptable hazard through fallout on nearby communities.

Each of the factors affecting fallout, discussed in a preceding section, must be considered when any test is proposed, to determine if it may be fired in Nevada or must be taken to the more isolated Eniwetok test site. The upper limit of the predicted yield for each experimental device must be matched against the proposed conditions, such as tower placement or air drop and radius of fireball, and a determination made as to whether the resultant radioactivity will be acceptable under the criteria and under the meteorological conditions expected after the detonation. Each Nevada shot is also fully evaluated again for those factors in the hours before any detonation, in view of the weather conditions then forecast.

Limitations on Yield

Scientists in the Los Alamos and Livermore weapons laboratories are guided by the public safety factors,

and therefore design the devices to be tested to have the lowest practical yield which will be sufficient to conduct necessary research and development.

Limitations are placed on the yield of experimental devices, or of weapons, which may be fired under various circumstances. These yield limitations are related primarily to whether the fireball will touch the ground.

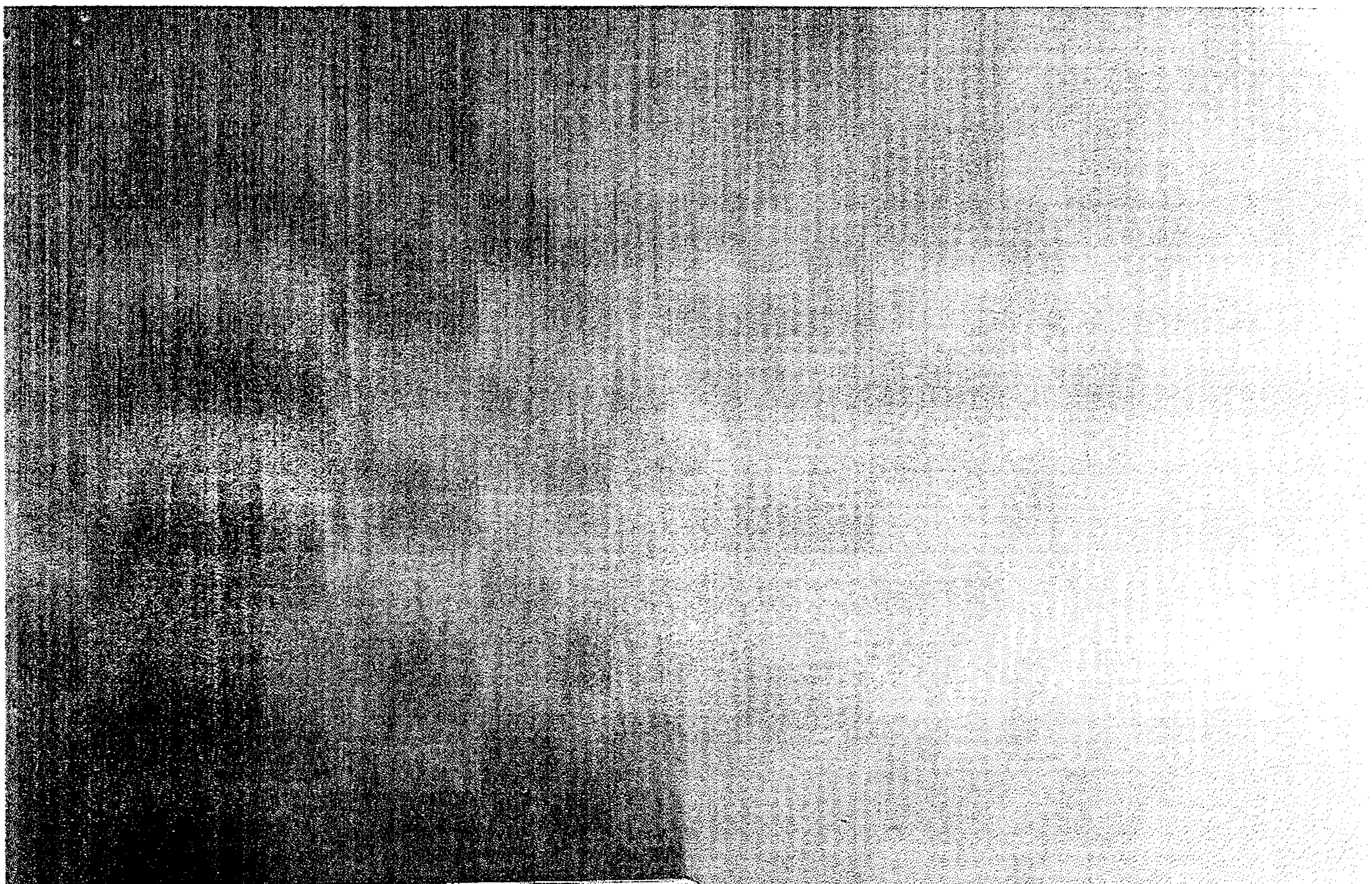
Shots to be fired at shallow distances underground or on the surface are limited to extremely low kiloton yield. Such shots in Nevada have created heavy fall-out radiation, but it has been confined to the test site and bombing range.

Techniques of Reducing Fallout

In order to reduce off-site fallout, detailed study has gone into the design of towers higher even than the 500-foot towers used in 1955.

As many tests as possible are planned as air drops, but needs for precise diagnostic instrumentation prohibit this method on most Nevada tests.

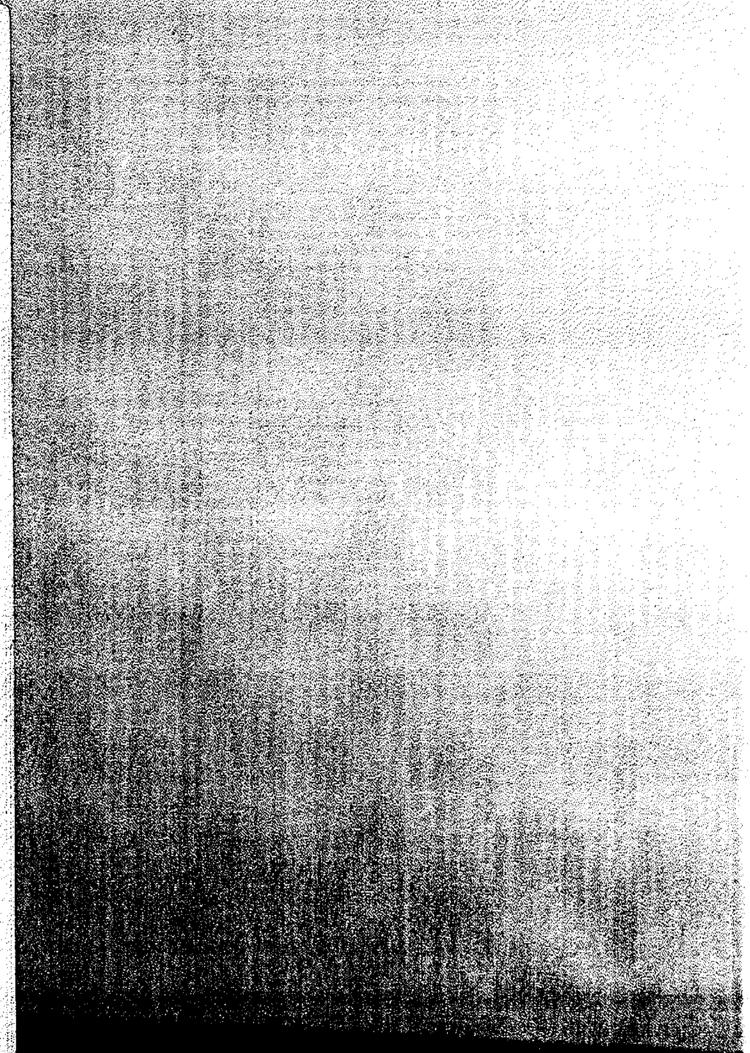
Technological developments have now brought to the fore the possibility of using captive balloons for those tests which permit some leeway in positioning the nuclear device. Experiments during 1955 and 1956 indicated that new-type anchored balloons could

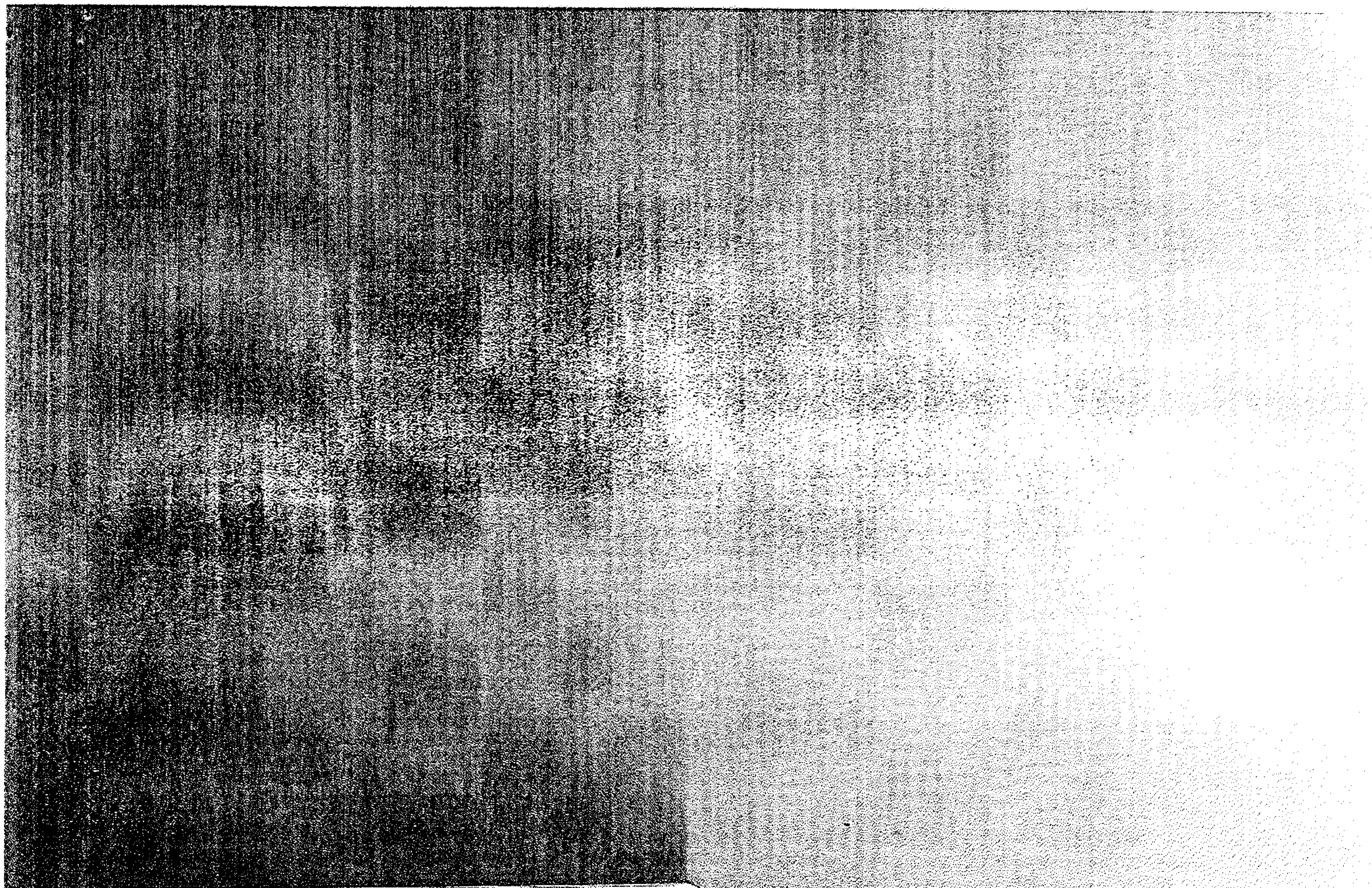


be made fully safe and would be practicable for certain shots. These balloons could be used effectively up to about 2,000 feet above ground level. Debris added to the fireball would come only from the balloon, its cab, some portion of the length of anchoring and data-recording cables, and any nearby recording equipment. Such shots should approximate air-dropped bursts in avoiding nearby fallout. If further tests confirm the feasibility of using balloons, several tests in the 1957 series will utilize this technique.

Another possible technique of reducing fallout would be to fire a shot deep underground, so that the radioactivity would be contained. To study the feasibility of such detonations, conventional high explosives with small amounts of radioactive tracers are being fired in underground tunnels at Nevada Test Site. These experiments will provide data on underground contamination and on ground shock transmitted off-site.

Weather continues to be a major consideration in keeping fallout to a minimum. Improved forecasting procedures include the use of rockets to show wind direction and speed shortly before zero hour. A shot will not be fired unless accurate forecasting is possible. Test management will continue to postpone any shot until the weather is acceptable for that shot.





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Warnings and Procedures

As in past series, every effort will be made to warn people away from the test site and the bombing range.

Helicopter and light aircraft sweeps of close-in predicted fallout areas will be made before a shot and any persons found there will be warned to leave. Like sweeps will be made following a shot. Stockmen will be advised if there are indications their stock has been exposed.

An extensive radiation monitoring system will be in operation in the test site region.

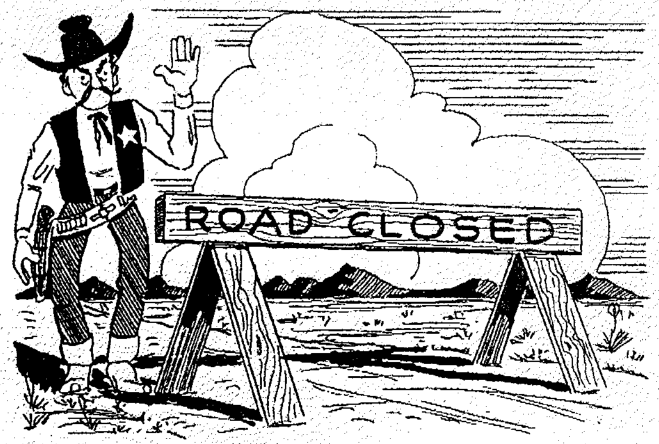
During the spring 1955 series, off-site monitoring was developed into an elaborate system to take numerous radiological measurements and also to provide close liaison with the residents of nearby communities. The U. S. Public Health Service stationed representatives in 12 zones east, northeast, and north of the site—the most frequent location of fallout. In addition, there were six mobile monitoring teams, staffed by the AEC and its contractors, on call to go to any locality if needed or to travel to areas outside the 12 zones. There were low-level aircraft sweeps to check ground fallout, as well as higher-level cloud tracking. Various automatic recording systems were used. Thousands of film

badges were worn by selected individuals and placed on buildings throughout the area.

These procedures will be followed in the 1957 series. Two will be expanded: (1) More people will be asked to wear film badges, in the continuing effort to determine more precisely the exposures to individuals under varying conditions. (2) Public Health Service monitors will be stationed in new areas generally south of the test site, extending into Arizona and California, which were served previously by mobile teams.

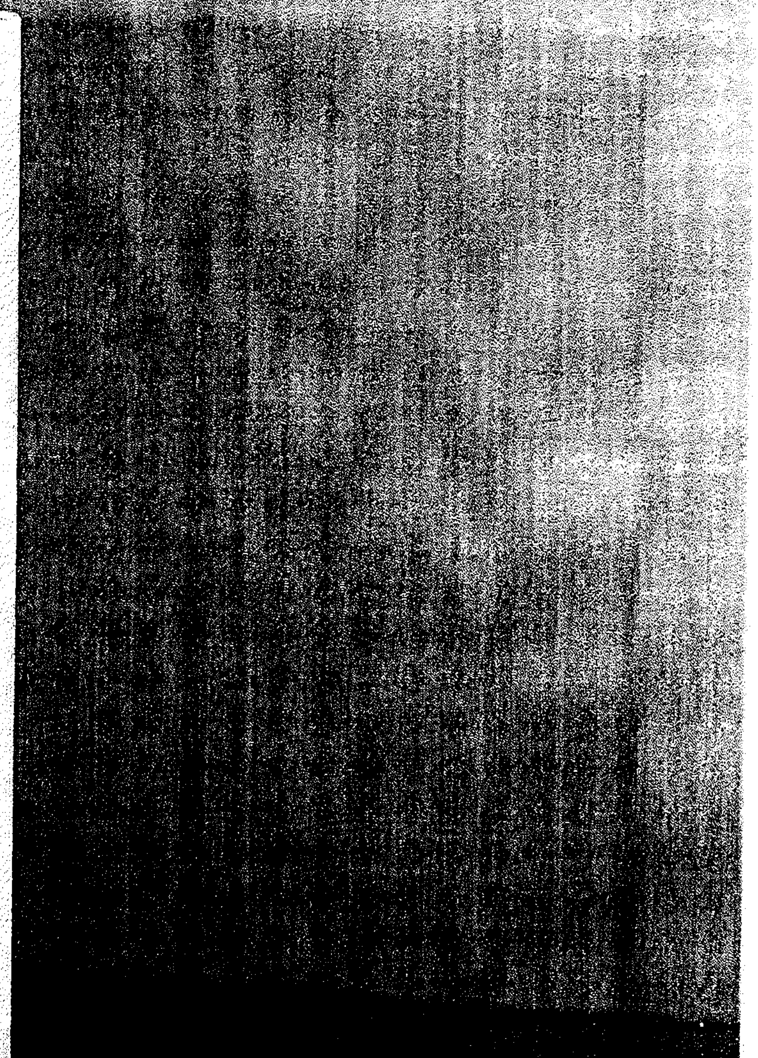
If you are in an area exposed to fallout, you will be so advised by our radiation monitors who will explain just what is happening. If there is any probability that your exposure will approach our conservative guides, you will be advised what to do. For example, at St. George and Lincoln Mine, residents were advised to stay indoors for a few hours until the fallout had ceased. If you were outdoors during the fallout, you might be advised to bathe, wash your hair, dust your clothes, brush your shoes, etc. If the fallout pattern is across a highway, traffic might be halted temporarily.

Your best action is not be worried about fallout. If you are in a fallout area, you will be advised. If your radiation monitors advise precautionary action, do what they say. Please bear in mind that it is extremely un-



likely that there will be fallout on any occupied community greater than the past low levels. If you think that maybe you have been in fallout, or if you have other questions, get in touch with our monitors or with the Nevada Test Organization.

Outside of the test site region, there is also a need to obtain data on fallout for scientific purposes and to provide information to the public. A network of AEC monitors, of U. S. Weather Bureau Stations, and a U. S. Public Health Service network will monitor at localities across the Nation. The Public Health Serv-

ice network, including representatives in all geographic areas, will keep state public health officials continuously informed of fallout so that prompt public reports may be issued.

THE FLASH OF LIGHT

The effects of the flash of light are essentially no different from those of sunlight. If you look directly into the sun (or at a photographer's flash bulb), you get black spots in front of your eyes for a few seconds or a few minutes. If you were much closer to the sun or if you used binoculars, eye damage might result.

On-site the thermal (heat) waves can injure eye tissues and cause permanent eye damage if one looks directly at the fireball. This is also true in the air above the test site. At shot time all personnel on or above the test site wear extremely dark glasses or turn away; binoculars are prohibited; and road traffic may be halted.

Off-site the same precautions should be followed by anyone in line of sight with the expected burst. The flash can cause "black spots" so that momentarily you can't see, or the flash can startle you if it is unexpected. This effect can be experienced at night many miles away. The greatest caution needs to be used by drivers

of vehicles or the pilots of aircraft who might have an accident if momentarily unable to see, or if startled.

The brightness of the light striking your eyes depends of course on whether it is night or day (at night, more light enters the dilated pupils), whether there is direct line of sight to the fireball, on distance, on atmospheric conditions, and to some extent on the yield of the device.

A majority of Nevada shots must be in the predawn hours of darkness and will require precautions against flash.

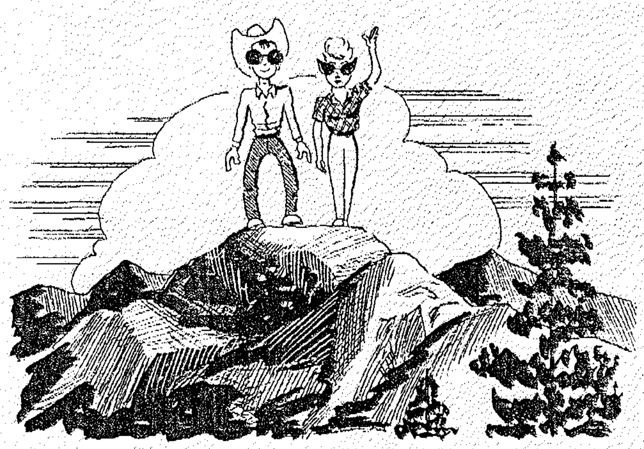
Past Experience With Flash

There have been no known cases of serious eye damage from light effects to people off-site. Some observers on nearby mountains, who did not wear dark glasses nor turn away, have reported temporary blind spots.

Off-Site Warnings and Procedures for Flash

Private and commercial air flights above the test site are prohibited. A circle about 65 miles in radius is established around the test site in which aircraft travel is restricted from 30 minutes before until 30 minutes after a shot (also because of radiation and air traffic congestion).

Some shots—because of time of day, very low yield,

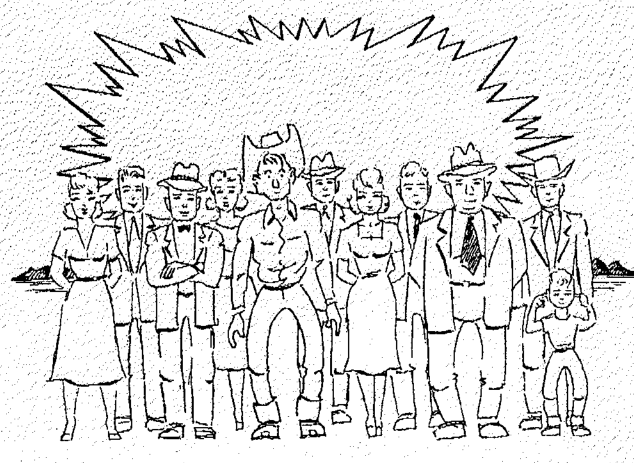


or their positioning—do not require off-site precautions.

If precautions are indicated, the Nevada Test Organization will announce the scheduled time of the shot and will recommend precautions. These may include the following:

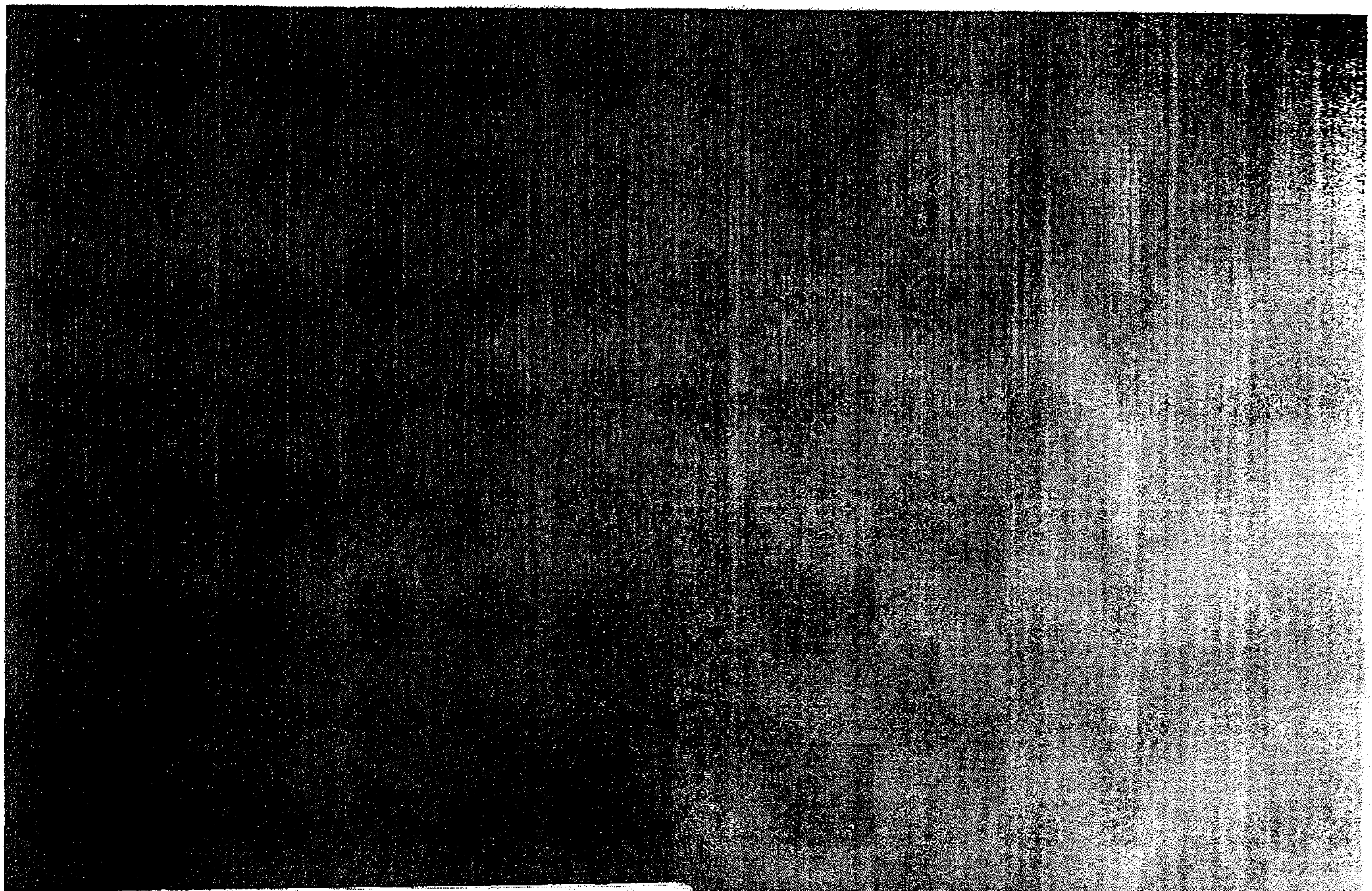
Day or predawn shots: Do not use binoculars or rifle scopes or other optical systems to look toward the test site at shot time. Do not look toward the test site at shot time unless you are wearing dark sunglasses.

Daytime shots: If the fireball will be visible on



highways within a radius of up to 60 miles, a general warning will be issued and insofar as possible those driving toward the test site will be warned of time of shot and advised to stop their cars and face away.

Predawn shots: If fireball will be visible on direct line to highways within a 60-mile radius drivers going toward the test site will be warned to stop at shot time. Persons in parked cars, or observers elsewhere, will be advised to look the other way or to wear two pairs of darkest variety sunglasses.



If a shot is postponed every effort will be made by radio and highway patrol to advise you so that you may proceed. Information on rescheduling will be given as soon as it is available.

THE SOUND, OR BLAST

Shock waves go out in all directions from the detonation. Some strike the earth and are dissipated. Some are reflected back to earth from various atmospheric layers. If they reach earth at an inhabited point they may be felt or heard.

Waves propagated through the troposphere (up to 6 miles high) cause sharp cracking and banging noises in the nearby site region. The strength of waves hitting in the nearby region depends on temperature and wind structure of the atmosphere, on altitude of the detonation, and on its yield. The point at which the wave will strike the earth is dictated by the altitude of the detonation and the meteorological structure of the atmosphere at that moment. Wind direction causes directional variation in blast. If the weather creates a lens effect in the atmosphere, blast intensity may be focused at a particular point and may be strong enough to break windows.

The ozonosphere, a layer 20 to 35 miles above the

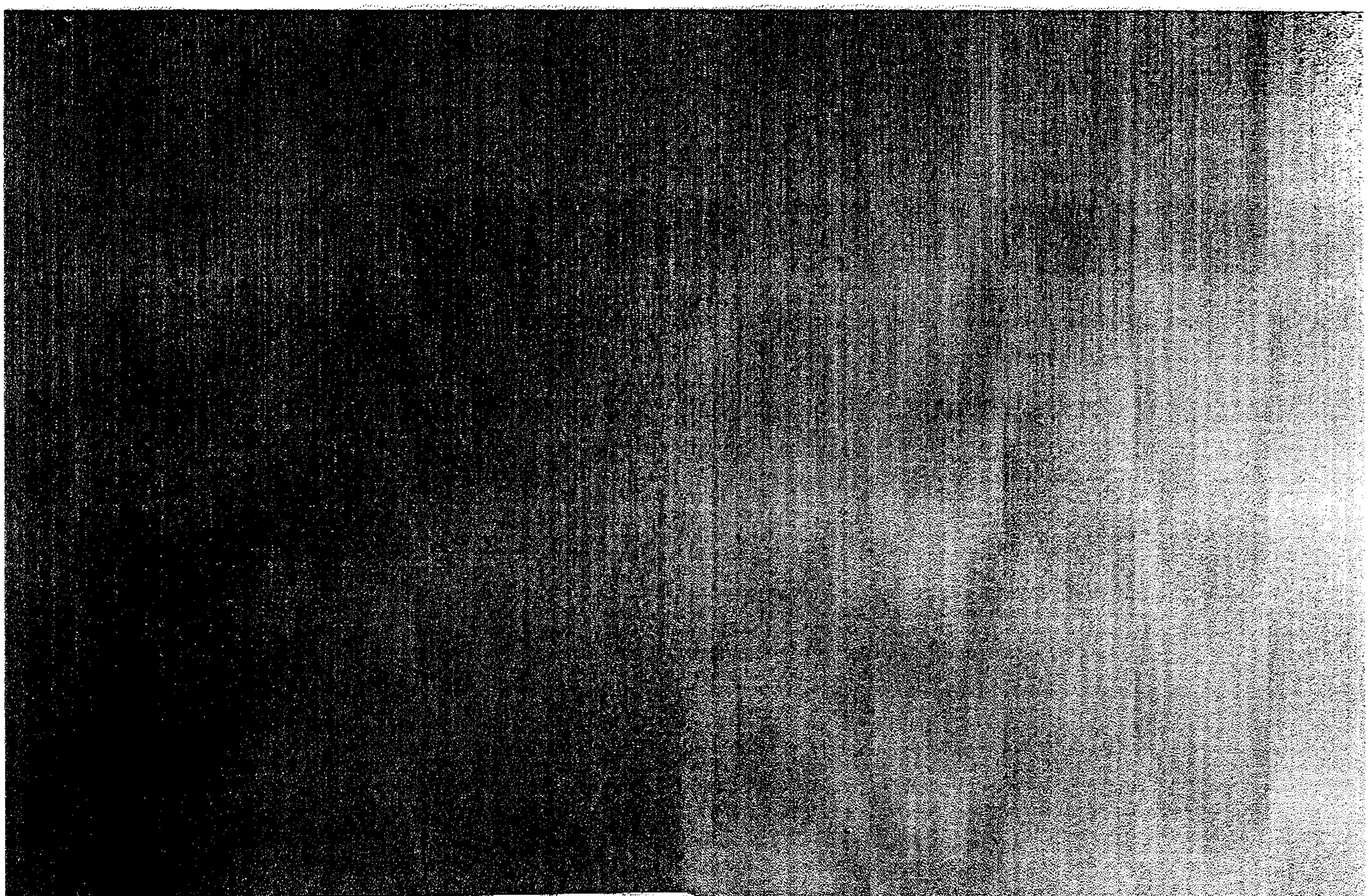
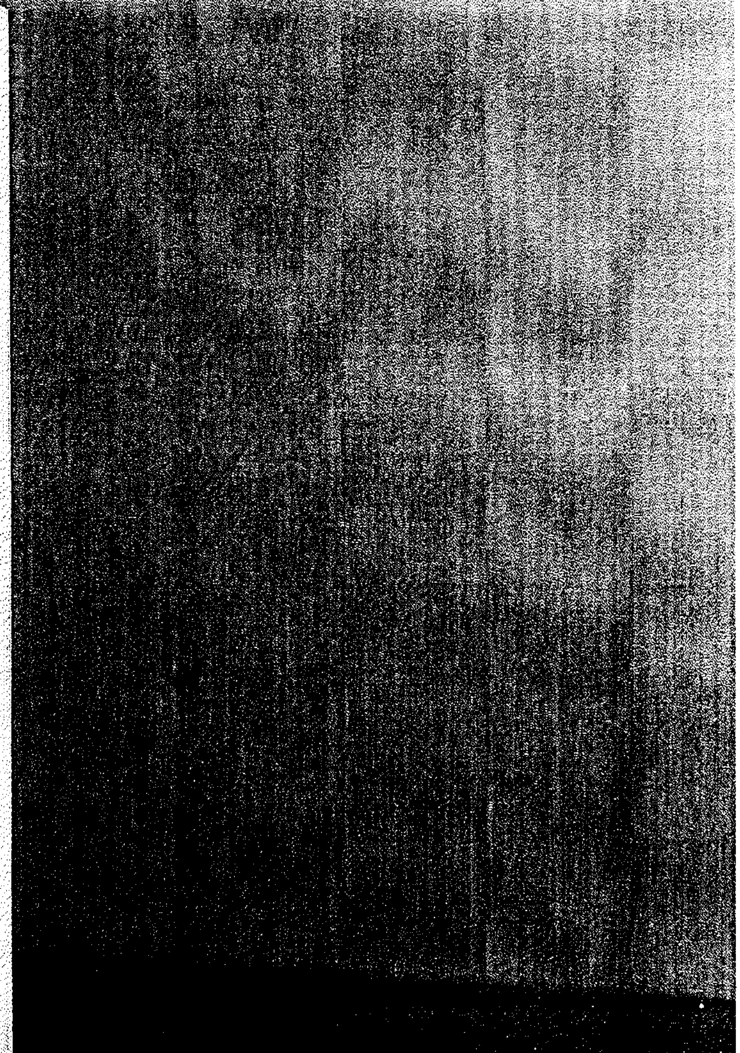
earth, bends waves back at distances from 60 to 150 miles. Usual ozonosphere wind directions cause these waves to reach St. George and Cedar City, Utah, in winter and Bishop, Calif., in summer. Every shot fired in Nevada has been heard either in St. George or Bishop, or both. The slowly oscillating, ozonosphere-borne waves can be as strong as others which break windows, and yet cause no damage. The sound is similar to the rumble of distant thunder.

Waves curved back to earth by the ionosphere, which is an atmospheric layer more than 50 miles above the earth, have been recorded on very sensitive instruments 100 or more miles from the target area. There is no evidence that they have been heard by people at that distance or have caused any damage.

Inasmuch as there is a possibility of jarring blast, which can break windows, from any Nevada shot, the effect should be anticipated for every shot and precautions should be taken throughout the nearby region.

Past Experience With Blast

Light damage to structures and broken windows have resulted within 100 miles of the test site. Most of these were in the two 1951 series, on a line from the test site through Las Vegas and Henderson. Blast has been

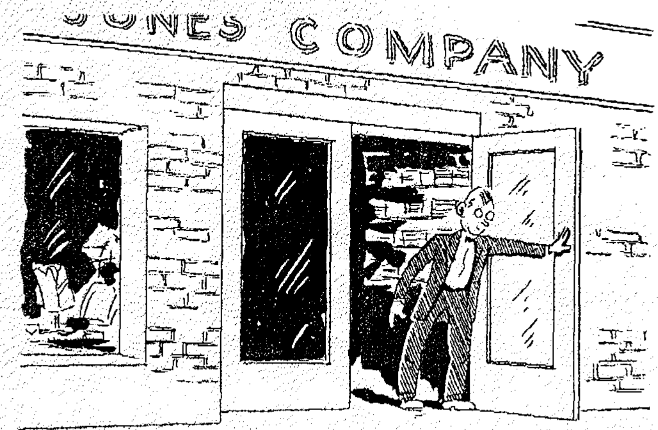
heard, but is not known to have caused damage, at greater distances, including Los Angeles, Calif., and Albuquerque, N. Mex.

Off-Site Warnings and Procedures for Blast

The Nevada Test Organization has a blast prediction and blast recording unit and devotes considerable effort to forecasting where blast may strike. High explosive shots are fired shortly before the nuclear test so the resulting blast can be recorded on sensitive instruments in communities around the test site. If the weather remains constant these provide a good indication of where the blast will strike, but if the atmosphere changes only slightly the point of impact may vary by miles. If strong blast is indicated for any community, under apparently stable meteorological conditions, the shot may be postponed.

When a possibility of slight damage to any community is indicated, the community is warned to open windows and doors to equalize pressure.

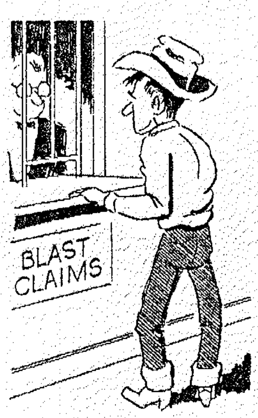
The warning procedure, coming as it usually must only a few minutes before shot time and usually in predawn hours when people are asleep, is not fully effective. Therefore, the most effective precaution for people in the nearby region is to anticipate blast from



every shot and to take simple measures such as opening windows and doors. Persons driving or sitting in automobiles should open the car windows. Another simple precaution is to stay away from large glass windows at shot time (windows usually break outward.)

REPORTING TEST-CAUSED DAMAGE

Since the first Nevada test series, the AEC has contracted with the General Adjustment Bureau to receive and to investigate claims for damages arising from test operations. An office is maintained is Las Vegas, Nev.



The Bureau's investigative teams are supplemented by engineers, architects, veterinarians, or other experts from the area where the asserted damage occurred. The investigation is thorough, in order to determine whether or not the claimed loss actually resulted from a test detonation. If found to be justified, settlement is relatively prompt.

If a claim is refused, or if it exceeds $5,000, you may still sue in Federal Court.

Almost all of the claims made as a result of tests have been for asserted damage from the blast effect, and a large majority of these were from the Las Vegas area as a result of the first two test series.

GENERAL INFORMATION

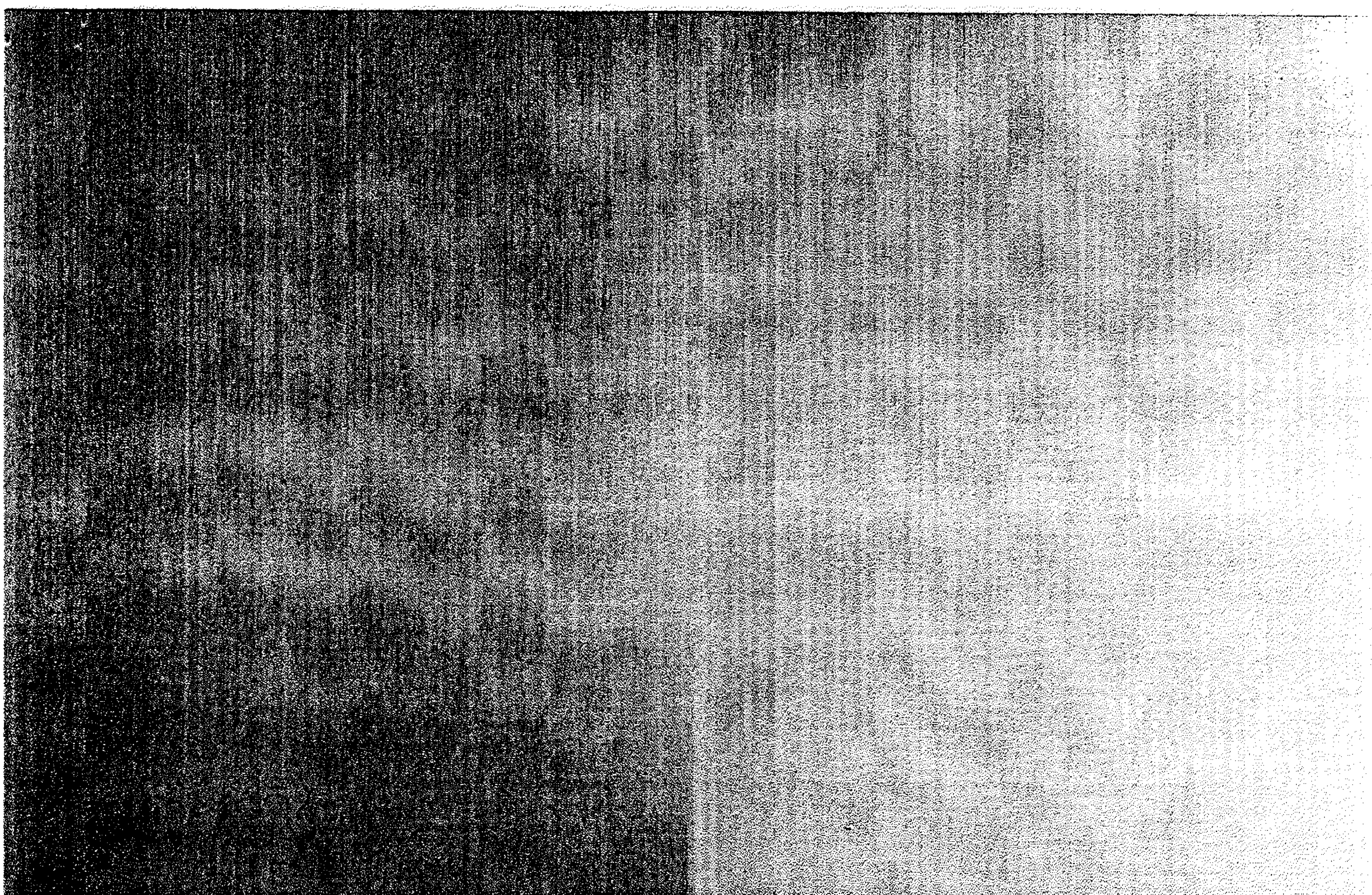
The Test Organization has an Information Office in Las Vegas at 1237 South Main Street, telephone Las Vegas Dudley 2-6350, and an Information Office at Camp Mercury, Nev., telephone Camp Mercury 1.

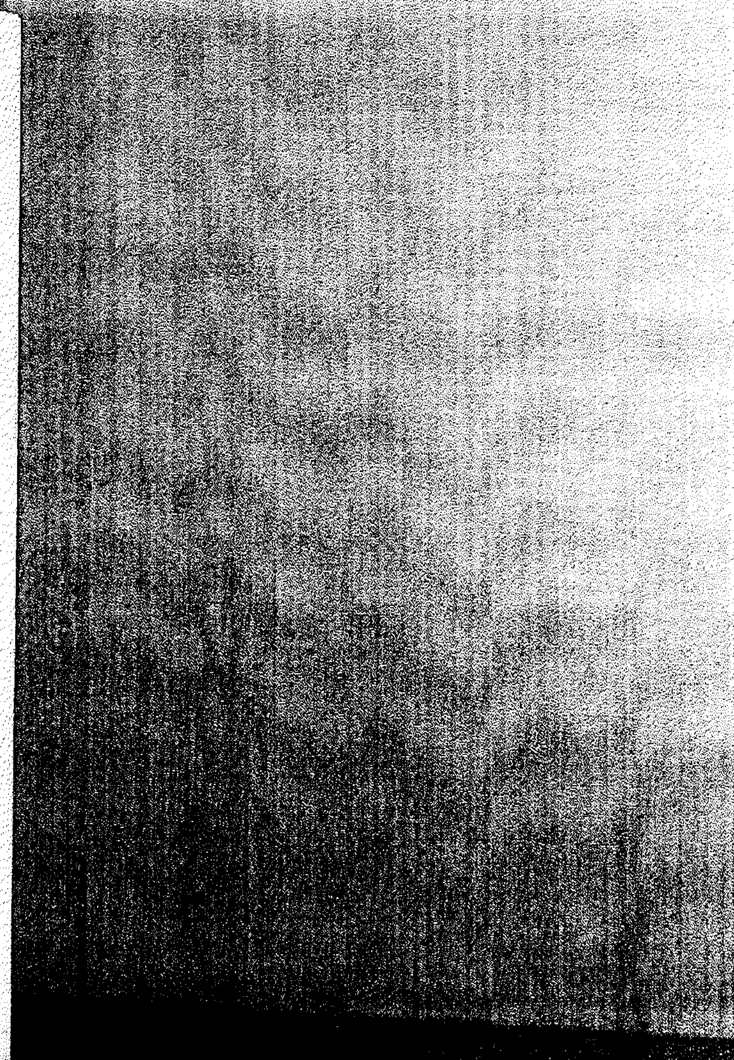
Quite by chance, some unusual weather accompanied Nevada tests during the spring of 1952 and 1953 (this was not the case in 1955). Lacking anything else to blame, some people thought the tests caused the bad weather.

You have lived next door to the test site long enough to know that weather is very important to us. We sometimes wait for days and days until the right weather comes along so that we can fire a shot. We don't create weather; we use it as it goes by.

Sometimes this means that shots are fired during a brief period of suitable weather which occurs between periods of strong winds. In such a case, strong winds will of course follow a shot.

For example, people in Las Vegas have noted during the day of an early morning test that a wind storm moved in from the northwest, seemingly from the test site. They haven't always realized that the same storm was moving toward them across California at shot time, and the Test Organization was taking advantage of the calmer period before the storm in order to control test effects. To a Tonopah resident, the sequence would have been different as he could have seen the early





morning flash in the southeast, then watched the clouds move in from the northwest.

The U. S. Weather Bureau experts, and those in our Armed Forces, have reviewed all of the facts. They have found no indication at all that Nevada tests change the weather anywhere in any respect.

APPENDIX

GUIDES TO UNDERSTANDING FALLOUT

How Radiation Is Measured

Radiation cannot be detected by the senses. Its effects can be measured with instruments, however, just as heat is measured by a thermometer. Various sensitive devices—a geiger counter is one—have been developed for this purpose.

In order to understand the subject, we need a measure for quantities of radiation, just as we use the quart as a measure for liquids, the volt for electricity, and the horsepower for our automobile engines.

Various units are used by the experts in measuring nuclear radiation. The basic unit used is a roentgen (abbreviation: "r."), named for the discoverer of X-rays.

Most of the fallout reports in the Nevada region use the term "milliroentgen." This is simply one

thousandth of a roentgen. Ten milliroentgen (or, "mr.") are one-hundredth of a roentgen; 500 mr. are only one-half roentgen.

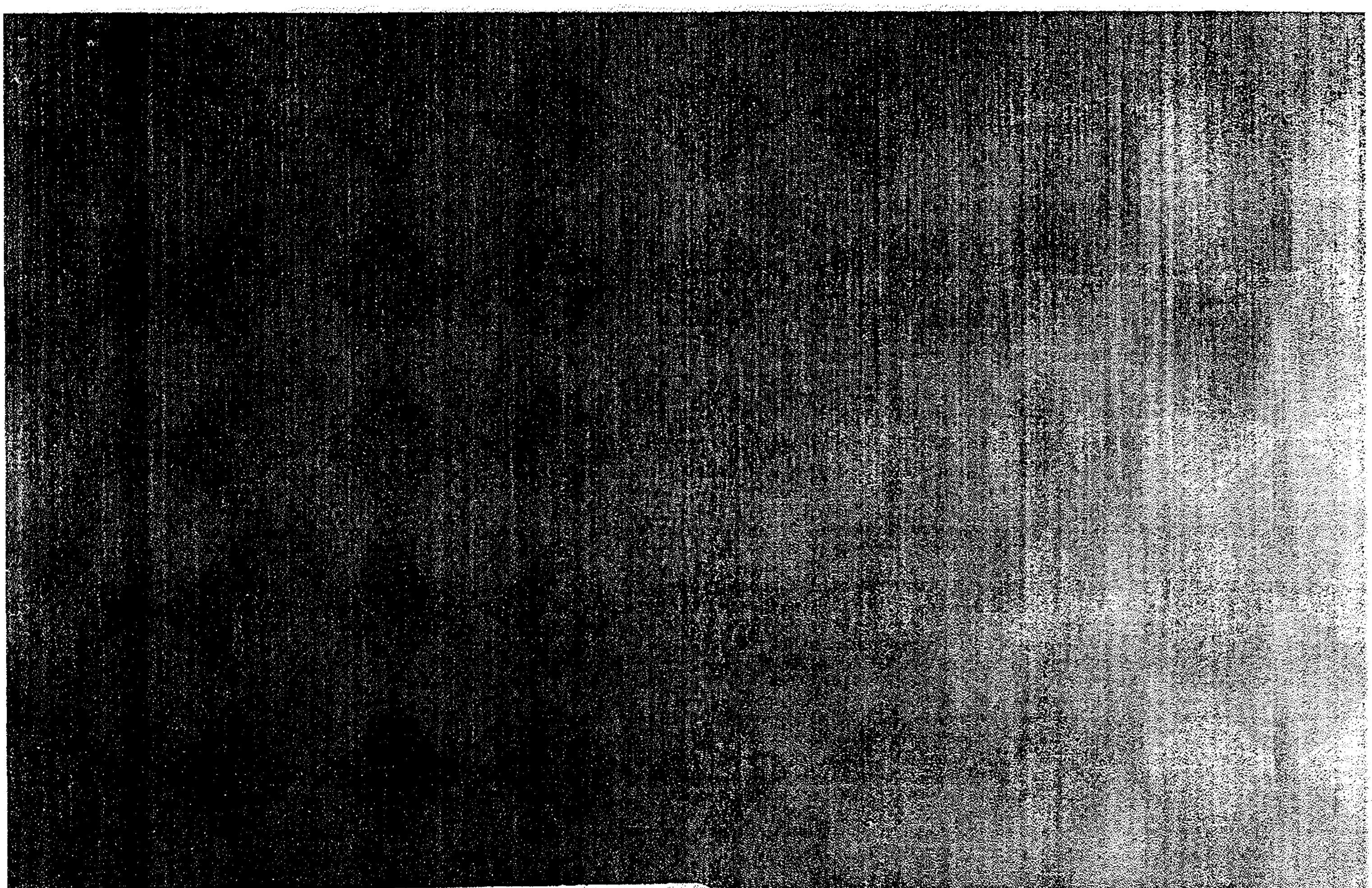
Radiation Is Nothing New

Very few of us can explain electricity, although we have learned to live with it and to use it. Even fewer can explain nuclear radiation. It is little understood by most of us, being something we can't see, feel, hear, taste, or smell.

And yet, radiation is nothing new. Since the beginning of time, mankind has been bombarded by radiation from outer space and from the ground beneath him. Cosmic rays rain down from space upon each of us every second of our lives. We are also constantly exposed to radiation from uranium, radium, and other elements in the earth itself. Each of us also has radioactive materials within his body. The sum total of this radiation is known as the background level.

Cosmic Rays Are Radiation

Cosmic rays at sea level give between 33 and 37 milliroentgens a year, depending on latitude and being least intense at the equator. At 5,000 ft. altitude, the dosages climb to between 40 and 60 mr. and at 15,000 ft. to between 160 and 240 mr.



The earth's surface everywhere is radioactive. Granite rock, for instance, contains radioactive radium, thorium, and potassium. Sea water contains little radiation. If you live on a ship on the ocean, exposure is greatly reduced.

Our bodies also contain radioactive materials, taken in with the food we eat and the water we drink. An AEC scientist illustrates his talks with an interesting experiment, in which the solid residue from a single sample of body fluid makes a geiger counter tick, as a piece of uranium ore would.

Your Body Contains Radiation

The natural radioactive carbon in your body exposes you to 1.5 mr. a year. The largest source of radioactivity in the body is potassium. It exposes you to 19 mr. a year. In fact, the radioactivity of the human body and the nature of its radiation are such that people receive radiation exposures from one another which are measurable. It has been calculated that people packed in a dense crowd would receive about 2 mr. a year dosage from the radioactive potassium in their neighbors' bodies.

Ground radiation, cosmic rays, and body radiation, if you live over granite rock, would total approximately

143 to 147 mr. a year exposure at sea level; 150 to 170 mr. a year at 5,000 ft.; and 270 to 350 mr. at 15,000 ft.

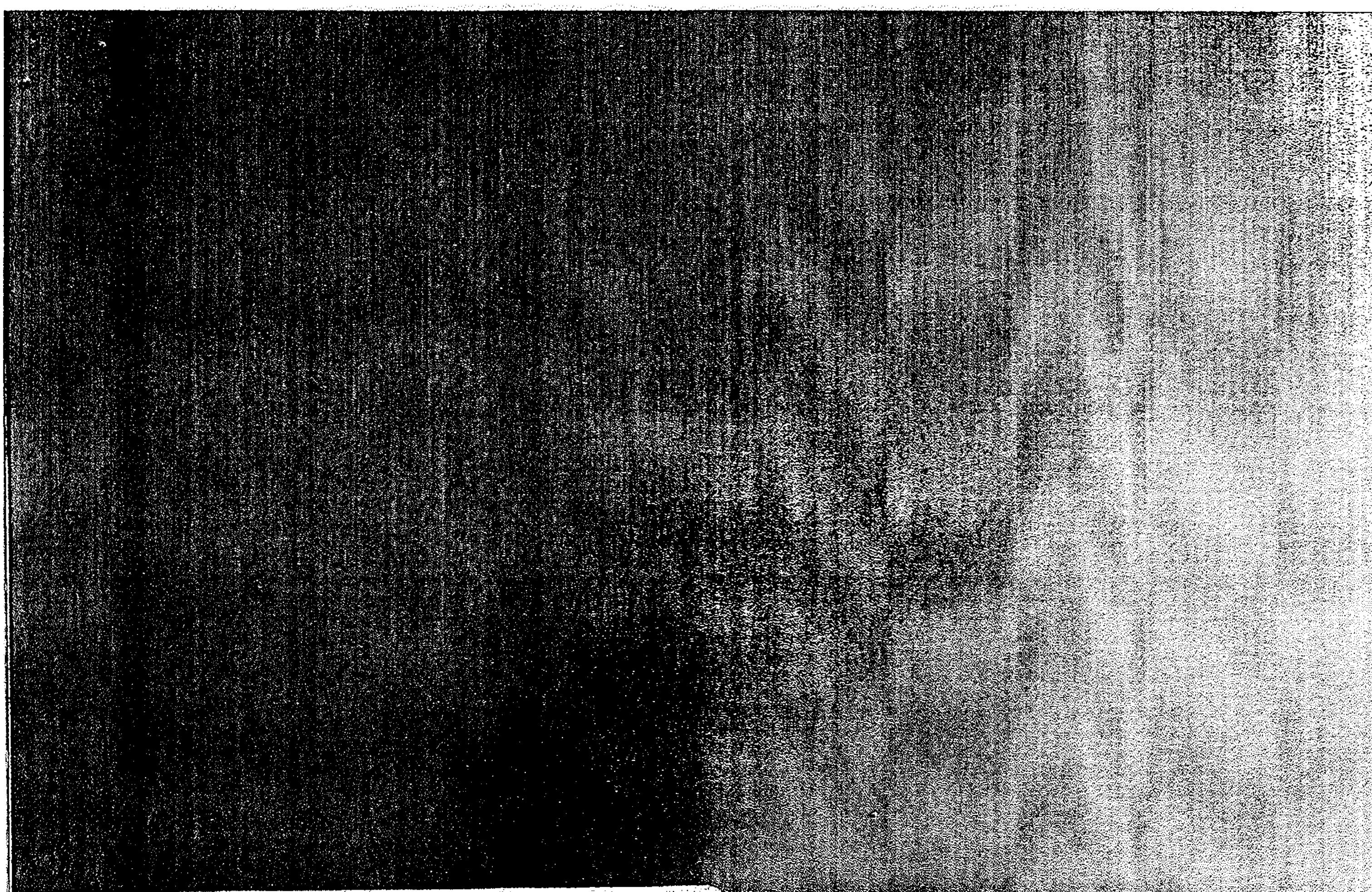
There are certain other exposures to radiation which persons willingly undergo. For example, a luminous wrist watch containing about one microcurie of radium per watch, will give 40 mr. a year to the central portions of the body. An airplane pilot's cockpit dials may expose him at the rate of 1.3 r. a year. Diagnostic X-rays involve comparatively heavy exposures to portions of the body.

So, radiation is not new to our lives. In this atomic age, it is important that we try to understand radiation, and to use it. It is also important that we respect its powers, so that we will be guided by knowledge and not be blinded by fears of the unknown.

What Radiation Does to People

Uncontrolled radiation, like uncontrolled fire or carelessly used electricity, can be very dangerous. Similarly, the sun will give you a pleasant suntan, but if you are overexposed it can burn the skin and make you quite sick.

Nuclear radiation does different things to people depending upon what kind it is, upon the amount to which a person is exposed, and whether the whole



body or only a part is exposed. Overexposure to any kind of nuclear radiation causes injury by damaging the tiny living cells of which our bodies are composed so that they cannot do their normal work in the body. The amount of overexposure to radiation determines the amount of damage caused. We become ill from radiation only if too many cells are damaged or destroyed at one time, or are destroyed continuously in certain organs of the body over a long period of time.

The body can withstand considerably greater doses of radiation than that from normal background because the effects are repaired almost as rapidly as they are produced. Over a period of many years, an individual could receive in small doses a total amount which would cause fatal illness if administered to his whole body within 24 hours.

High levels of radiation can produce effects such as blood and intestinal disorders, or delayed effects such as leukemia and cancer.

Ranges of Exposures

A total of 25 to 50 roentgens received in a brief period, will produce temporary blood changes, but will not cause illness. Radiation sickness may follow exposure somewhere in the 75–125 r. range, with nausea and vomiting occasionally found as low as 100 r. Serious

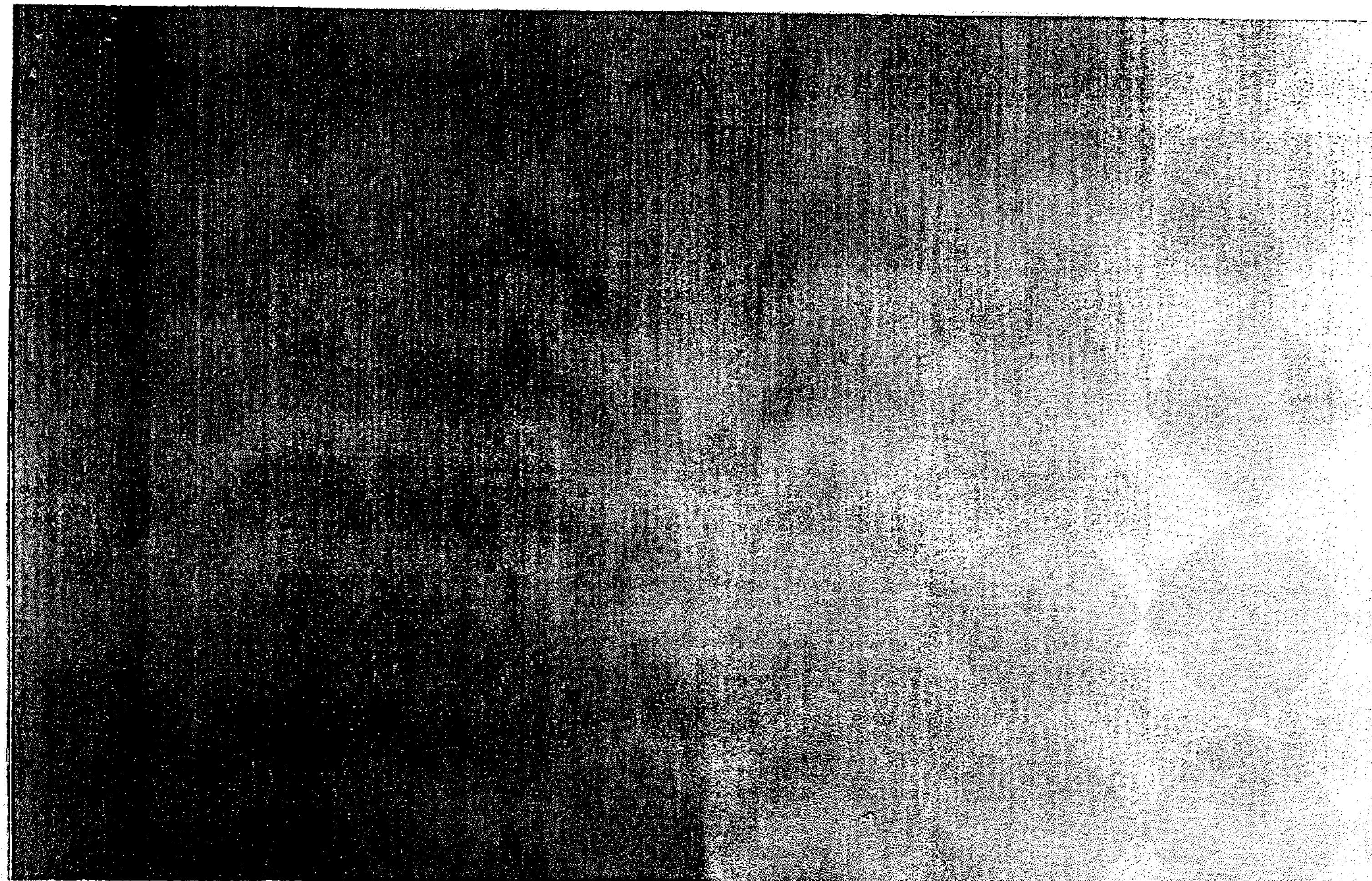
illness, from which people will recover with proper attention, may result at the 200 r. level. Exposure to 400–500 r. in a brief period may kill 50 percent of all persons exposed. Very large single doses (more than 800 r.) which strike all or most of the body would cause death in a great majority of cases.

Internal Radiation

Strontium–90, one of the radioactive products of nuclear fission, is the principal fallout material which might present a potential health hazard when taken into the body by swallowing or inhaling.

A unique combination of qualities makes this substance especially critical. It is one of the more abundant fission products. Its half-life is 28 years and it will thus remain active for many years. It is chemically very similar to calcium and so is taken up and concentrated by bone tissue which has an affinity for calcium. In sufficient concentrations it is known to cause bone tumors in experimental animals, through its emission of beta rays.

Strontium 90 has been deposited all over the globe by fallout. It is produced by all fission-type detona-



tions, in lesser quantities by lower yield Nevada tests and in greater quantities by high yield tests elsewhere in the world.

The isotopè is taken up by plants from their leaves or from the soil. A safety factor here is that nature has wisely provided a built-in mechanism for discriminating against the uptake of radiostrontium in favor of calcium by plants. From the plants, the radiostrontium may be transferred direct to man or through animals to man as in the case of milk. Both animals and man also have a like built-in mechanism discriminating against uptake of radiostrontium.

Some children in the United States have accumulated a measurable amount of radioactive strontium in their bodies. The amount, however, is quite small—about a thousandth of the permissible dose for adult workers. The amounts of strontium that have been found up to the present in milk and meat and animal products are detectable, but they are very low.

The Effect on Inheritance

The inheritance mechanism is the most sensitive to radiation of any biological system.

Every cell in the human body contains a collection of tiny units called genes. Taken together they sub-

stantially determine all the characteristics the individual is "born with." Each person gets his genes from his parents, who got them from theirs, and so on. For example, there are genes which determine hair color, others which control stature, and so on.

Ever so often a gene changes or "mutates," and a characteristic is altered. We know a number of ways to bring about mutations. Heat, certain chemicals and radiation will do it. And once changed, the new form of the gene is then passed on as faithfully as the old one was.

Infrequently a mutation will turn out to be helpful. Evolution has depended on a sequence of rare mutations, each of which produced an organism slightly better equipped than its ancestors to deal with the environment. Plant breeders are continually looking for helpful mutations that will give improved crop varieties. But the exceptions merely prove the rule that most mutations are genetically harmful.

Any radiation dose, however small, can induce some mutations. Every generation of living things acquires some mutations from natural causes (background radiation, heat, or certain chemicals). These are called "spontaneous mutations." Genetically, the amount of radiation that counts is the total accumulated dose to

the reproductive cells of an individual from the beginning of his life to the time his child is conceived.

It is easy enough to say that radiation causes genetic damage, but to define and measure the damage is very difficult. The National Academy of Sciences report estimated that exposure between 30 and 80 roentgens to the reproductive organs could cause as many additional mutations in the individual who received it as now occur spontaneously. It is estimated that at present something like 2 percent of all United States children are born with some noticeable genetic effect. If the population on a whole were subjected generation after generation to an additional 30 to 80 r., this figure would gradually rise to four percent. It also was concluded that for a small number of individuals exposed to 30 to 80 r., no statistical study could possibly establish the fact that their children or their children's children had directly suffered damage.

The NAS report estimated current levels of radiation exposure in the United States as follows:

"At present, the United States population is exposed to radiation from (*a*) the natural background, (*b*) medical and dental X-rays, (*c*) fallout from atomic weapons testing. The 30-year dose to the gonads received by the average person from each of these sources is estimated as follows:

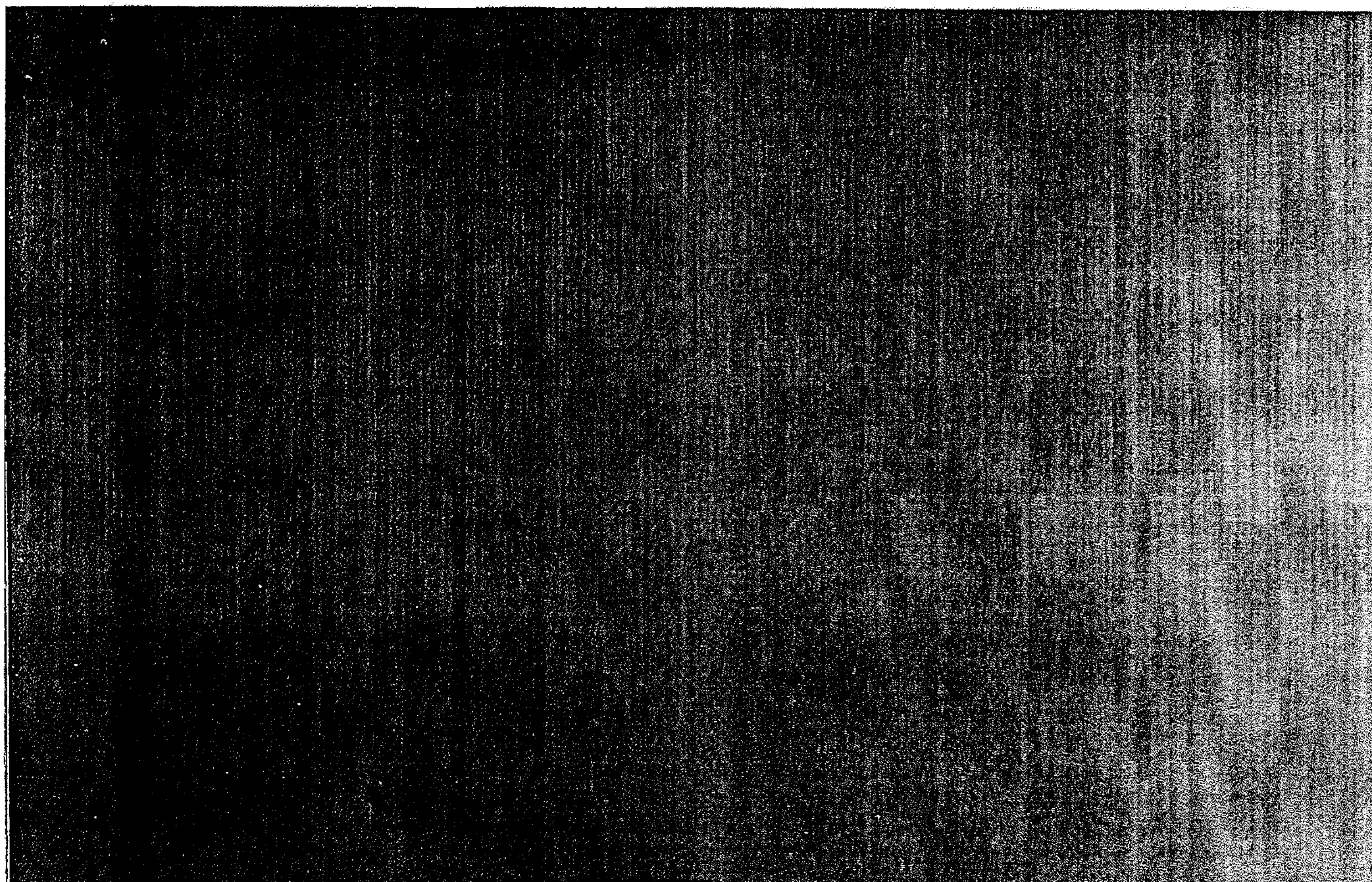
(a) background—about 4.3 roentgens
(b) X-rays and fluoroscopy—about 3 roentgens
(c) weapons tests—if continued at the rate of the past 5 years would give a probable 30-year dose of about 0.1 roentgen. This figure may be off by a factor of 5, i. e., the possible range is from 0.02 to 0.5 roentgens. If tests were conducted at the rate of the two most active years (1952 and 1954) the 30-year dose would be about twice as great as that just stated."

The Chairman of the NAS genetics panel concluded that bomb test fallout is at present the least harmful genetically of the three sources of radiation—natural background, X-rays, and fallout.

Possible Shortening of Life Expectancy

There is some evidence, both from animal experiments and mortality statistics of radiologists, some of whom may have received as much as 1,000 roentgens of X-ray exposure over a period of years, that radiation exposure shortens life expectancy. However, not very much is known about the quantitative relations between exposure to radiation and shortening of life.

Research has been chiefly concerned with the effects of large quantities of radiation, and studies of continued



radiation at low levels so far have given inconclusive results. The National Academy of Sciences report stated on this point: "The shortening of life correlates roughly with doses of radiation but has not yet been demonstrated at low doses." The NAS also stated: "Doses up to 100 roentgens, when spread over years, have not been shown to shorten human life. On the other hand, we cannot yet say that there is a minimum amount below which the effect does not take place."

Permissible Exposures

As the preceding discussion indicates, a great deal of research has been devoted to determining the effects of radiation and learning how much radiation people can accept without significant risk. As a result of these studies, "permissible limits" for exposure to external radiation and "permissible concentrations" of radioactive materials in the body have been established. In the United States, these standards are recommended by the National Committee on Radiation Protection, an advisory group of experts on radiation. The National Committee works closely with an international body, the International Commission on Radiological Protection.

Since 1948, the maximum permissible exposure to penetrating external radiation has been 0.3 roentgen (300

milliroentgens) per week for atomic energy workers. Very few atomic energy workers actually have received this amount of radiation even for short periods, however, because of the Commission's policy of keeping exposure to a minimum.

Recent studies have indicated that, in addition to the weekly limit stated above, there should be limits on average exposures to radiation which may be incurred over long periods of time. It also is generally recognized that large populations should not be allowed to receive as much average radiation exposure as relatively small groups of adults, such as workers in the atomic energy industry. These additional limitations are considered necessary largely because of the potential effects of radiation on inherited characteristics and on life expectancy, as noted in the preceding discussion.

The National Committee on Radiation Protection recently made recommendations to the effect that:

(1) The exposure of atomic energy workers should not exceed an *average* of 5 r. per year past the age of 18, provided that no annual exposure exceeds 15 r.

(2) Exposure of the population of the United States as a whole from all sources of radiation, including the natural background, should not exceed 14 million r. per million of population over the period from conception

up to age 30, and one-third that amount in each decade thereafter.

These recommendations are similar in intent to recent recommendations of the International Commission on Radiological Protection, the National Academy of Sciences, and the United Kingdom Medical Research Council.

ATOMIC ENERGY COMMISSION
UNITED STATES OF AMERICA